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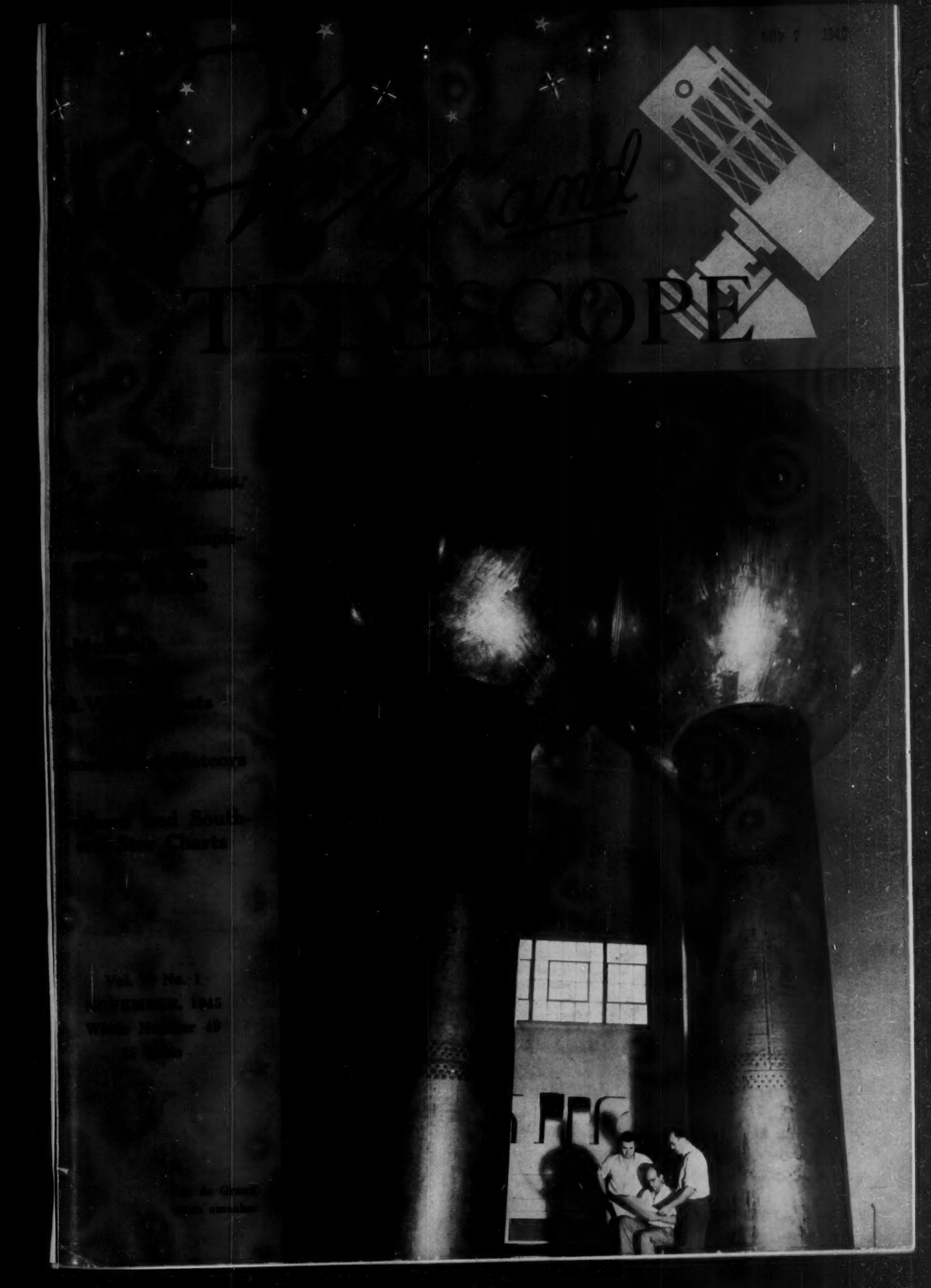
Field and TELESCOPE



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Whole Number 49

WORLD HONORED
Longines, the world's most honored watch, has won 10 world's fair grand prizes and 28 gold medals. Product of Longines-Wittnauer Watch Co., New York, Montreal, Geneva

Sky and TELESCOPE

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In Focus

ATOM SMASHING may be done with various devices, of which the Van de Graaff generator is one of the largest. Pictured on our front cover is the huge electrostatic generator built by the Massachusetts Institute of Technology for direct-current bombardment of atomic nuclei at a potential of more than two million volts. This generator was built from designs of Dr. Robert J. Van de Graaff, a member of the Institute's department of physics.

The great spherical aluminum terminals are 15 feet in diameter, with the supporting columns six feet in diameter and 25 feet high. These columns, which must be non-conducting, are made of thousands of layers of paper cemented together with a special shellac. Inside the columns, rubber belts 48 inches wide operate vertically, as shown in the diagram on page 3, carrying electrical charges up to be stored on the surfaces of the terminals. In this way, a relatively small difference of voltage may be enormously increased for the purpose of bombarding atomic nuclei with fast-moving charged particles.

The nuclear researches carried on with cyclotrons and Van de Graaff generators have not only contributed to military science—in peacetime, astronomy will be one of the sciences to benefit from our advancing knowledge of the atom. Comets are riddles of the cosmos which nuclear physics may help to solve; with such riddles Dr. Felix Cernuschi's article beginning this month is concerned.

The most famous of all comets, Halley's, is pictured on the back cover this month.

Because of their peculiar structure and habits, comets hold a key position in problems of the cosmogony of the solar system. A comet's head is so tenuous that, as the back-cover picture shows, stars may be seen right through it. The stars appear as short streaks because the camera is made to follow the motion of the comet during the exposure. In 1910, when this picture was taken, the head of the comet appeared to decrease from about 150,000 miles in diameter, before it reached the sun, to about 25,000 miles across. This apparent shrinking is believed to be caused by the disruption of molecules of certain compounds, such as carbon, CH, and CN, by the increasing absorption of short-wave solar radiation. Each time a comet passes perihelion it is subject to this disruptive action and to the loss of material into its tail as a result of radiation pressure. (See page 12.)

VOL. V, NO. 1
Whole Number 49

CONTENTS

NOVEMBER, 1945

COVER: The Van de Graaff atom smasher of Massachusetts Institute of Technology. Photo, courtesy of the Institute. (See In Focus.)

COSMOGONICAL IMPLICATIONS OF THE ATOMIC BOMB—Felix Cernuschi 3

AL-MULTAHIB—George A. Davis, Jr. 8

AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS MEETS 10

COMETS AND METEORS—Marian Lockwood 12

Amateur Astronomers	11	News Notes	7
Astronomical Anecdotes	6	Observer's Page	16
Books and the Sky	14	Planetarium Notes	20
Gleanings for A.T.M.s	18	Southern Star Chart	22
In Focus	2	Stars for November	23

BACK COVER: The head of Halley's comet, as photographed on May 8, 1910, with the 60-inch reflector at Mount Wilson Observatory. (See In Focus.)

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COSMOGONICAL IMPLICATIONS OF THE ATOMIC BOMB

By FELIX CERNUSCHI, *Guggenheim Fellow at Harvard University*

1. The atomic bomb and astronomy

AN AMAZING FEATURE of science is its tendency to increase the interactions between its different branches — science becomes more functional and more organic as it grows in every direction. The extraordinary amount of scientific research which was primarily done in the United States to help win the war against the enemies of democracy presents plenty of evidence along these lines.

The methods and techniques of modern physics have started important advances in diverse branches of engineering and in other practical and important fields directly related to warfare, and which may now be applied to increase the solidarity between all the peace-loving and democratic peoples all over the world. Radar and underwater sound are illustrations of what victory owes to physics. May the place of the theoretical physicist not be forgotten in the organization of peace. Many astronomers have been among those doing researches in different fields of applied physics.

The most extraordinary product of science research carried on under the purpose of war, the atomic bomb, gives new impetus to some hypotheses which the writer proposed in 1939 to explain supernovae[1] and the origin of cosmic rays.[2] Further development of these ideas, which some years ago sounded too bold, is now encouraged, and they may furnish important applications of nuclear chain reactions to astronomical problems. Perhaps chain reactions produced by the impact of neutrons in stars with neutron cores may explain not only supernovae, but also ordinary novae; some types of pulsating stars which cannot be interpreted with Eddington's theory and the known modifications of his theory; the formation of double stars and in general the origin of multiple-star systems; the origin of cosmic dust and meteors; the behavior of those stars which do not fit into the known models of the internal constitution of stars; the strong ionization of helium in the sun's atmosphere, by modifying Saha's theory of the solar corona; the origin of the chemical elements; the evolution of the universe in a rather different manner from previous proposals, and phenomena resulting therefrom.[3]

In preparation for a discussion of these ideas, we shall first make a general survey of the atomic bomb's basic physical phenomena: fission of heavy elements by bombardment by neutrons. Then, we shall discuss the most interesting results and researches connected with the bomb's perfection and point out some peacetime applications of them. This will lead us to astronomical processes similar to those in the bomb, including reactions possible under special conditions in stars with neutron cores, and the results of such processes.

EDITORIAL COMMENT

IN 1939, while physicists were exploring the possibilities of the then newly found uranium fission, an Argentinian astronomer studying in the United States presented revolutionary thoughts concerning the role of neutrons in astronomy. In the series beginning here, our readers may share Dr. Cernuschi's first-hand understanding of the astronomical significance of the atomic bomb.

Among Sky and Telescope articles on physics related to astronomy which may be worth reviewing for their connection with nuclear physics are: Dr. Frank's discussion of relativity, Oct.-Dec., 1942; Dr. Swann's story of cosmic rays, May-Aug., 1944; and the recent series on the nature of light, by Dr. Macdonald, Aug.-Oct., 1945. Also, energy production in the stars was discussed by Dr. Bethe in The SKY, Dec., 1940; by Dr. Marshak in The Telescope, Nov.-Dec., 1940; by Dr. Payne-Gaposchkin in Sky and Telescope, July, 1943.

2. An important fundamental particle: the neutron

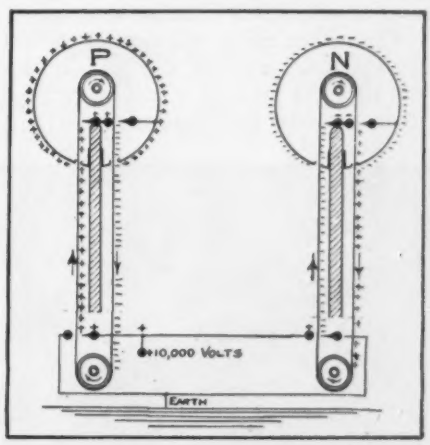
MORE THAN 15 years ago, by bombarding the nuclei of beryllium atoms with alpha particles (helium nuclei), Bothe and Becker[4] observed a very penetrating radiation which they thought to be gamma rays (very high-frequency electromagnetic radiation). But Curie and Joliot[5] found that the new radiation, when passed through hydrogen-containing compounds, for example, paraffin, had the property of throwing out protons (hydrogen nuclei) of high velocity—too many to be produced by gamma radiation. Finally, Chadwick,[6] as a result of studies of the recoil produced by the new radiation on nitrogen nuclei, suggested that the former consisted of material particles without electrical charge, in other words, of *neutrons*. The Bothe-Becker experiment was a case in which beryllium and helium combined to produce carbon and neutrons and some excess energy, as follows:

$$ {}_4Be^9 + {}_2He^4 \rightarrow {}_6C^{12} + {}_0n^1 + \text{Energy} \quad (1) $$

Here the subscript represents the electric charge (Z) of the particle, which is also its atomic number, and ranges from one for hydrogen to 92 for uranium, and even higher. The superscript gives the mass or atomic weight to the nearest whole number.

If the energy of the incident alpha particle is of the order of 10^5 electron volts (1 e.v. $= 1.5911 \times 10^{-13}$ ergs), the energy of the emitted neutron is of the order of 6×10^6 e.v., and on the average one neutron is produced per 20,000 incident alpha particles. Most efficient methods of producing streams of neutrons use deuterons, nuclei of heavy hydrogen atoms, of atomic weight 2, as bombarding particles. The deuterons are accelerated in a cyclotron or Van de Graaff atom smasher (see the front cover and In Focus), producing the following reactions:[7]

$$ {}_1D^2 + {}_1D^2 \rightarrow {}_2He^3 + {}_0n^1 + 3.2 \times 10^6 \text{ e.v.} \quad (2) $$



This diagram shows how rubber belts 48 inches wide carry up electricity to charge the spheres of the Van de Graaff generator pictured on the front cover. The charges distribute themselves on the surfaces of the spheres, one sphere being positive (P) and the other negative (N), giving the tremendous difference in electrostatic potential.

But this reaction may also give:

$$_1D^2 + {}_1D^2 \rightarrow {}_1H^3 + {}_1H^1 + 3.97 \times 10^6 \text{ e.v.} \quad (2')$$

With deuterons of 0.8×10^6 e.v. energy, the following may take place:

$$_3Li^7 + {}_1D^2 \rightarrow 2\ {}_2He^4 + {}_0n^1 + 14.6 \times 10^6 \text{ e.v.} \quad (3)$$

$$_4Be^9 + {}_1D^2 \rightarrow {}_5B^{10} + {}_0n^1 + 4 \times 10^6 \text{ e.v.} \quad (4)$$

By observing the results of these reactions in a cloud chamber, and with the help of the laws of conservation of energy and momentum, we may fix with great accuracy the mass of the neutron as 1.00893 atomic units, which is about 0.0013 greater than the mass of the proton. By consideration of the electric charges involved, many physicists believe that a proton plus a negative electron produce a neutron. But taking into consideration the fact that the mass of the neutron is greater than the mass of the proton, we believe that it is more correct to write the following relation:[8]

$$\text{Mass proton} + \text{Energy}/c^2 = \text{mass neutron} + \text{mass positron} \quad (5)$$

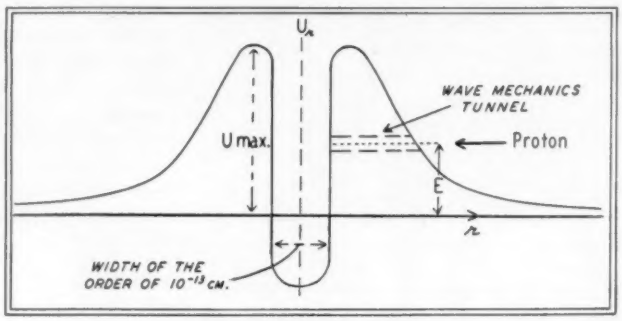
From Einstein's equation for the equivalence of mass and energy, $E = mc^2$, and replacing the given values in (5), we can determine the suggested binding energy of a neutron and a positron.

One atomic unit of mass has an energy of 1.483×10^{-3} ergs or 0.932 electron volts, and vice versa. If reaction (5) is the correct one, the binding energy of a proton formed out of a neutron plus a positron would be of the order of 0.7×10^{-6} ergs. This would be necessary to split a proton into a neutron and a positron. To convert one gram of protons into neutrons would use about 4×10^{10} joules, which equals 0.95×10^{10} gram calories or 11,000 kilowatt hours.

The reasoning here is similar to that by which we explain the well-known fact that the mass of a helium nucleus (two protons plus two neutrons) is less than the sum of the masses of the separated component particles; the energy generation of the sun is explained in Bethe's famous carbon cycle by the formation of helium atoms out of hydrogen atoms and the consequent liberation of energy equivalent to the difference in masses.

In this cloud-chamber photograph, a proton entering from the right strikes the nucleus of a nitrogen atom and rebounds. The momentum of the proton is shared with the nitrogen nucleus, causing it to move along the short track to the right of the point of encounter.

In cloud-chamber experiments, electrons and protons and other electrical particles ionize the gas particles in the chamber and moisture droplets condense on the ionized gas particles along the tracks of the charged particles. Thus, we may "see" such particles, but, as the neutron has no electrical charge, it produces practically no ionization in a cloud chamber and, consequently, no visible track. From the photographs of tracks of electrical particles participating in a nuclear reaction which also involves a neutron, a vector polygon of the momentums of the particles involved may be drawn, and by applying the momentum conservation law it is possible to determine the vector corresponding to the neutron.



A graphical representation of the potential barriers of the nucleus. Probability laws predict that occasionally protons of rather low energy may enter as if through a "probability tunnel."

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3. Neutrons and atomic nuclei

BEFORE THE discovery of the neutron, atomic nuclei were supposed to be formed of protons and electrons. In carbon, for example, six electrons were thought to neutralize the charges of six protons, and an additional six protons gave the nucleus its electric charge of 6 (atomic number) and its total mass of 12. But certain experiments contradicted this view as did also some results of wave mechanics, so that until 1932 the knowledge of nuclear constitution was in a very critical state. But the neutron opened up new vistas in research and theory.

Now we believe the nucleus of an atom to contain protons equal to its atomic number and the number of satellite electrons for a neutral atom. In addition, the nucleus contains neutrons to equal the remaining atomic mass. Carbon, therefore, of atomic mass 12.0036, is formed of six protons and six neutrons, while the isotope of carbon of mass 13.0073 has one neutron more. In general, the isotopes of the same chemical element are determined by the number of neutrons —by changing the number of neutrons one may get all the possible isotopes corresponding to the same element; by changing the number of protons, one changes the atomic number and, consequently, the chemical element.

The radii of the nuclei are of the order of 10^{-13} centimeters (1/10,000,000,000,000 cm.), and such extremely small regions are packed with protons and neutrons to form the cores of the chemical elements and the greatest sources of energy known.

The diagram represents Gamow's potential barriers of a nucleus. When any positively charged particle, such as a proton, approaches the nucleus with an energy E, the particle experiences a repulsive force derived of the like charges of nucleus and particle; the corresponding potential energy is Ze^2/r. Here Z is the atomic number of the nucleus involved, e the charge of the proton, r the distance between the nucleus and the bombarding particle. This statement of electrical potential is in accordance with Coulomb's well-known law of static electricity.

Classically, the positively charged particle ought to have an energy at least equal to U max. in order to enter the nucleus. But in wave mechanics it is proved that the particle may actually hit the nucleus with an energy much smaller than U max. by crossing the potential barrier through a "probability tunnel."† This conclusion is in perfect accord with experimental results. Of course, the particles inside the nucleus may escape through such probability tunnels, which is the explanation of radioactive emission.

But when the distance between a positive particle and the nucleus is about the radius of the nucleus itself, about 10^{-13} cm., the nucleus produces an attractive force instead of repulsion. This accounts for the drop in the central part of the diagram, for there the repulsion has become reversed in sign.

† See *Sky and Telescope*, September, 1945, page 12.

This is the region in which Coulomb's law does not hold, so that it is possible to pack large numbers of positively charged particles together to make up the atom's nucleus. If Coulomb's law were absolutely true all matter would be disintegrated into protons and other elemental particles.

The energy which keeps protons and neutrons together within the nucleus is called the packing energy, and its value is calculated from the difference in the mass of the nucleus as a unit and the sum of the masses of its component neutrons and protons, taken separately. This difference multiplied by the square of the velocity of light gives the packing energy. The mass of an alpha particle, or helium nucleus, is 4.0039, whereas the contained protons and neutrons separately weigh 2×1.00758 and 2×1.00893, which totals 4.03302. The difference in these masses is of the order of 0.03 mass units, which is equivalent to 4.5×10^{-5} ergs per nucleus; 7.5×10^{5} kilowatt hours would be needed to separate all the protons and neutrons in the nuclei in a gram molecule of helium.

Masses of atomic and fundamental particles are usually measured in a mass spectrograph or by another electromagnetic device. Those who would like to have a general knowledge of the techniques and methods used in nuclear physics may wish to read *Applied Nuclear Physics* by Pollard and Davidson, and *The "Particles" of Modern Physics*, by Stranathan.

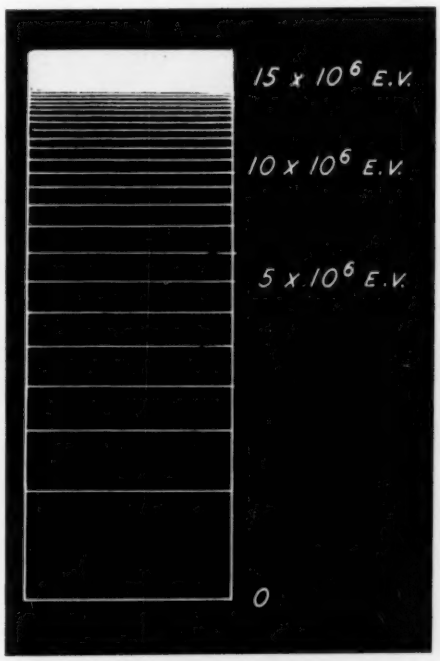
In spite of many recent advances, very little is really known quantitatively of the law of forces which keep together the fundamental particles within the nuclei. There is no doubt that these forces are of the saturation type, and unlike gravitational forces, which may act on an unlimited number of particles. They are in some way similar to the chemical forces which hold atoms together to form molecules: when the molecule is complete, the valency forces are saturated and it is not possible to add another atom to the molecule. Similarly, in a nucleus, an indefinite number of neutrons cannot be added without producing radioactive emissions—the isotopes of a chemical element are very limited in number.

To have stable nuclei, therefore, it is necessary to have protons and neutrons in some definite ratio. In the lighter elements, protons practically equal neutrons, but in the heavy elements neutrons far outnumber the protons. For instance, uranium, of atomic number 92 and mass 234, 235, or 238, has 92 protons and 142, 143, or 146 neutrons. The neutrons seem to be an indispensable cement.

In considering the problem of disrupting heavy nuclei, after the ideas of Bohr,[9] we first note that if the bombarding particles are positively charged protons or other atomic nuclei, the repulsive force produced by the positive charge of the bombarded nucleus is very great and proportional to the atomic number of that nucleus. We can better analyze heavy elements by bombarding them with neutrons, for the electric repulsion does not affect them. Fermi[10] and his collaborators were among the first to use neutrons to produce artificial radioactivity: a nucleus of not too large an atomic number, struck by a high-velocity neutron, is very apt to capture the neutron but directly thereafter it may emit an alpha particle or a proton—it becomes artificially radioactive. It may also emit a negative electron, or beta particle. The cross-section (S) of the nucleus for the process involved is defined by $S \times N = P/I$, where N is the number of target nuclei per square centimeter, P is the number of processes occurring, and I is the number of incident particles.

In another experiment, it is proved that a neutron may be captured by a heavy nucleus with the emission of a gamma ray and the formation of a new isotope which may be either stable or radioactive according to circumstances. The uncertainty principle‡ states that the uncertainty in the energy involved times the uncertainty in the time of the process equals Planck's constant *h*.

‡ See *Sky and Telescope*, September, 1945, page 12.



A ladder to show how the energy levels of the nucleus get closer together and practically merge at high energies of excitation.

The game of the atomic nucleus, originated by Bohr to show what may happen in a nuclear collision. The marbles roll down the flat stick and "bombard the nucleus," overcoming its "repulsion" by rolling up the incline of the inverted pie plate. Experiment and photograph by Science Service.

The gamma radiation from the above process enables us to show that the unsettled state of the nucleus lasts much longer than 10^{-20} second after the neutron bombardment. A fast neutron requires about 10^{-21} second, or less than 1/10 this time to go across a distance of nuclear dimensions.

These considerations led Bohr to conclude that the first result of a neutron-nucleus collision is a compound system of great stability, and the later change whereby a material particle or a gamma ray is emitted must be considered as a separate process not directly connected with the first stage of the encounter. Bohr also supposes that the excess energy of the incident neutron is rapidly divided among all the nuclear particles with the result that for some time afterward no single particle will possess sufficient kinetic energy to leave the nucleus. Furthermore, any subsequent emission of a particle must result from a very complicated process by which the energy happens to be again concentrated on some particle at the surface of the nucleus, but of this process we have no exact picture.

Graphically, Bohr[11] pictures the analogy of a shallow basin with a high curved border representing Gamow's potential barrier and a number of (billiard) balls to represent the neutrons and protons. Another ball, coming in from outside, would probably not go through without striking first one ball and then others, which would in turn divide this energy with the remaining balls. If the basin and the

(Continued on page 20)

ASTRONOMICAL ANECDOTES

MORE ABOUT THE CAROLINA BAYS

TO CONTINUE with Professor Johnson's "test case" in methods of scientific research, we come next to his section on analysis of observations and inferences. As a first step, he examines very critically all the observational data and there uncovers much that is important.

First, the usual statement that the Carolina craters are oval is a careless one, at best, for there are systematic departures from simple oval form; the northeastern sides of the bays are prevailingly more strongly curved than the southwestern sides. Many of the craters are pear-shaped, not oval, the narrower ends toward the southeast. The tendency is for meteoritic impact craters to be nearly circular, but certainly no meteorites coming from the northwest would produce scars that are smaller at the southeastern ends.

The parallelism of the craters, so often emphasized, is violated so many times that the exceptions become more important than the conformities. There are many divergences by more than 50 degrees, even up to 80 degrees in a few. Some of the craters are arranged in chains, "conforming," says Professor Johnson, "perfectly to the trend of the beach ridges. It is difficult to believe that falling meteorites could so perfectly adjust their points of impact to a pre-existing topography."

The apparent confirmation of meteoritic origin derived from the overlap of the area of the bays and the area of most numerous meteorites becomes less than confirmation when we find that the overlap is hardly more than one per cent; near Columbia, S.C., there is a small overlap, while at least 99 per cent of the area of most abundant meteorites avoids the area of craters. No meteorites have been found in or near any of the bays or craters.

The magnetometer survey, in which magnetic highs are found at the southeastern ends of selected craters, was not complete. As soon as large areas are surveyed with the magnetometer, there is found a marked elongation of the highs in the northeast-southwest direction, exactly the direction of the ancient stone structures bearing iron. They lie beneath a wedge-shaped coastal plain with its thin edge inland and thick edge toward the sea. As the magnetometer surveys approach the sea, the effects fade out, because the old iron-bearing strata lie deep beneath the coastal plain. The conclusion is that "what was apparently the strongest support of the meteoritic hypothesis vanishes" because iron in meteorites is not conceivably responsible for the derived effects first announced.

While Professor Johnson does not insist in his article in the *American Scientist* that he has discovered the exact mechanism of origin of the craters, he describes one that he believes is a sufficient first approximation. It involves several phenomena, including subsidence of the soil due to solution and carrying away of the stone beneath the craters, bubbling of sand from artesian springs, formation of multiple ridges through action of wind, and other recognized geological processes.

Professor Johnson was also the author of an entire book on *The Origin of the Carolina Bays* (Columbia University Press, New York, 1942), which was reviewed in the February, 1943, issue of *Sky and Telescope*. It pleases me that Dr. Westgate, whose judgment in matters geological I shall certainly never question, agrees that Professor Johnson is correct in his conclusions, for he closes his review with the statement that this "seems a reasonable explanation of the facts . . . and it will be the basis for any further study of the bays."

Meanwhile, however, the old story spreads. The blundering article that appeared first in the *Saturday Evening Post* for September 9, 1944, then was reprinted in *Reader's Digest* of June, 1945, has now been included in *The Science Yearbook of 1945* as one of the best popular magazine articles on current phases of science! Everything about it is good except the facts, and Waldemar Kaempffert, reviewing the book in the New York *Times*, speaks of the Carolina bay report as "a wild piece on a comet which was supposed to have smashed into the southeastern coastal plains. . . . No geologist of repute considers the markings found as those of a comet" or, he might well have added, of anything else that came in from the outside.

The cure for bad science writing is not obvious. A partial cure could certainly be effected if editors would realize that in any large city, scientists in any field can be found at the end of a telephone, and editors should get acquainted with them if they are going to print articles on science. Maybe even a scientist might have something interesting to say about science!

R.K.M.

LETTER TO THE EDITOR

Sir:

I promised sometime ago that I would send you a report on my 13-inch telescope which I recently made. I would have done so before but for the fact that at 5:00 a.m. on March 3rd a rocket fell a stone's throw away, utterly demolishing 14 houses. My own house was badly damaged with ceilings down and all glass blown out—an indescribable mess.

My poor telescope was blown off its brick pier and was left lying with one or two holes in the tube through which broken bricks and dust had entered. Although the mirror cell had received a nasty knock, the mirror was unharmed.

Well, we have got a bit straight now and I am repairing the telescope for use this season. The mirror is of Pyrex glass; when the blank arrived I found it half an inch thicker at one edge than the other, tapering from 3″ to 2½″. I ground the faces parallel with very coarse carborundum using an old iron rammer head. For the edging I mounted a bench drill horizontally, putting a bolt in the flywheel which engaged a screw in a wooden disk pitched to the mirror blank. On the other side a similar wooden disk was pitched, with an old gramophone motor fixed horizontally. Thus, when the handle of the drill was turned the disk was made to revolve. I did not think that this setup would be strong enough but it worked perfectly.

The grinding of the curve went well until I noticed that Ellison in his book recommended alcohol as a better medium for the fine grades of carborundum — well, I tried methylated spirits with the result that mirror and tool seized up and were inseparable. I nearly despaired! Finally I supported the mirror face down in a bath of water and heated it on the gas stove. Not until the water was quite hot did the mirror leave the tool and sink to the bottom of the bath.

I used both the pinhole and Ronchi tests and succeeded in obtaining a very good figure free from zones and other defects. With the limited opportunity I have had of using the telescope it has given me great satisfaction. The tube is hexagonal and is made of board named Prestwood, which when painted seems unaffected by weather. I made about seven wooden hexagonal "rings" to which the six sides of the tube are screwed. Around these, on the outside, are screwed bands of one-inch galvanized iron. The finished tube is strong and looks extremely well.

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NEWS NOTES

By Dorrit Hoffleit

ELECTRONIC AIDS TO ASTRONOMY

War-inspired advances in electronics promise to put many useful instruments into the hands of alert astronomers. For example, electronic telescopes, automatic meteor plotters, and star-counting machines have for some time received consideration by astronomers, even if all have not achieved definite success. Such devices are in the stages of practical development, and a brief summary of the possibilities of various equipment is given by Arthur C. Clarke in the *Journal* of the British Astronomical Association.

Radar-tracking equipment may ultimately perform highly accurate parallax work in the solar system. The time interval required for a radio pulse to be reflected back from a distant object tells the distance of the object. Echo delays of about eight seconds (corresponding to a distance of 744,000 miles) have been recorded. Others up to 12 minutes (68 million miles) have even been reported but not confirmed. Thus it appears that echoes from the moon should offer no insuperable difficulties, and the accuracy in distance attainable promises to be of the order of a fraction of a mile! Moreover, as the character of the echo depends on the nature of the reflecting surface, radio ranging might eventually answer such questions as, for example, whether or not there are oceans on Venus.

CRYSTAL LENSES

Commenting on the expense of good optical glass and the disadvantages of plastic substitutes, F. Henroteau, astronomer now with the Farnsworth Television and Radio Corporation at Ft. Wayne, Ind., describes briefly a method for obtaining crystal optical parts suitable for astronomical purposes. "Transparent crystals, grown to any size, are absolutely homogeneous and have constant refractive indices. Many crystals, moreover, are transparent in a much wider range of the spectrum than glass." Such crystals (sodium chloride, potassium bromide, lithium fluoride, and others crystallizing in the cubic system) had been produced by special techniques involving fusion followed by slow cooling. Methods are being developed at the Farnsworth Corporation to produce crystals from solutions in water. A crystal of ammonium alum weighing 4½ pounds was recently obtained and could have been grown larger still by accretion.

Apparatus has been designed whereby lenses can be made out of soluble cubic crystals using controlled dissolution. A rigid form of the desired shape is made of insoluble material; the form is cooled and moist air blown toward it, forming a thin film of moisture on the mold. A crystal "attached to a rigid stem which moves back and forth by means of a motor is brought into contact with this film and then removed. A thickness of the order of one micron is dissolved where the crystal was in contact with the film. The dissolved part is then blown off," and the operation repeated until the crystal has assumed the shape specified by the mold.

The paper, abstracted in the *Astronomical Journal*, was intended for presentation at the cancelled February meeting of the American Astronomical Society.

TAMM NOVA STUDIED

The absolute magnitude of the new star discovered on August 28th by Dr. Nils Tamm, of Sweden, Nova Aquilae 1945, has been estimated at about —6.8. This is based on spectra taken at the Dominion Astrophysical Observatory, Victoria, B. C., by which Dr. C. S. Beals determines from the widths of the interstellar calcium (K) line a distance of 2,550 parsecs or about 8,000 light-years.

These spectra also show displaced double absorption lines of hydrogen, indicating that shells of gas are expanding from the star at rates of 2,150 and 1,330 kilometers per second.

This nova in Aquila has now faded to the 10th magnitude; its maximum brightness was probably of the 6th magnitude.

McCORMICK DIRECTOR APPOINTED

Successor to Dr. S. A. Mitchell as director of the Leander McCormick Observatory of the University of Virginia is Dr. Harold L. Alden, who received his doctorate from that university in 1917. In 1925 he left Virginia, where he was then associate professor, to become astronomer in charge of Yale University Observatory's station at Johannesburg, South Africa.

Dr. Alden is well qualified to carry on the excellent parallax traditions of the McCormick Observatory, since his own researches have dealt mainly with parallax and proper-motion problems. He has also done research on photometry, double stars, and variable stars.

He is an internationally recognized astronomer—a fellow of the Royal Astronomical Society, and a member of the Société Astronomique de France, and of the Astronomical Society of South Africa.

METEORS AND LUNAR EARTHSHINE

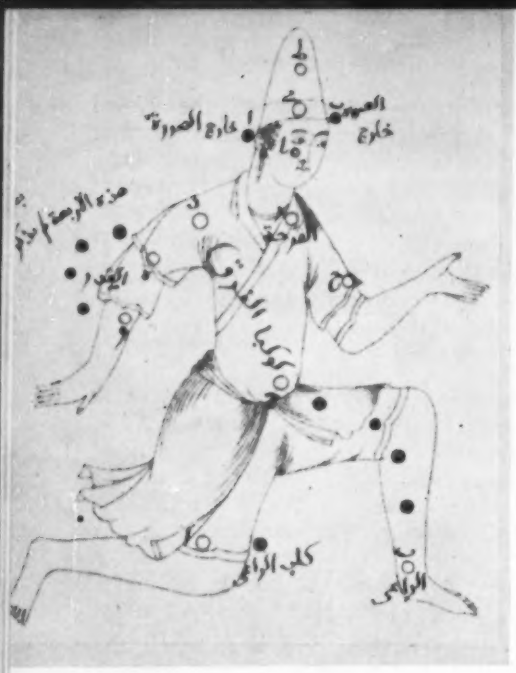
The "old moon in the new moon's arms" is a well-known effect of the reflection of sunlight from the earth onto the dark side of the moon. The brightness of the earth-lit moon is not always the same, but depends on the moon's distance, its position in the sky, and meteorological conditions at the "reflector" — the earth. Apart from these conditions, Mohd. A. R. Khan, president of the Hyderabad Academy, India, suggests (in *Popular Astronomy*) that variations in the intensity of the dark side of the moon might be found to depend on meteoric activity. While observations of lunar meteors have been most difficult to obtain and always subject to skepticism, the variations in the brightness of the lunar surface might be quite accurately measured. Increases presumably apart from the fundamental causes mentioned have at times been observed, notably by Elihu Thomson on November 7, 1921.

"Bombardment of the nearly airless, practically unprotected, lunar surface by an unusually abundant swarm of meteorites . . . may have given rise to the appearance. . . . It would be a profitable piece of research to correlate the luminosity of that portion of the moon visible under earthshine with meteoric displays observed on our planet. . . . During rich showers of meteors there would be hardly 3 hours' difference between the times of the meteoric activities taking place on the Earth and those occurring on the moon." The problem sounds intriguing: whether or not the hoped-for correlation with meteors is found, such research is bound to reveal valuable data on the earth's atmosphere.

TEXAS AMATEUR DIES

In the Texas Observers' *Bulletin* for August, tribute is paid to Sterling Bunch, Ft. Worth amateur astronomer and one of the original Texas Observers. He died in July, only 45 years old and in the midst of a very active life.

Among Mr. Bunch's scientific interests were meteorology, in which he worked for the Weather Bureau from 1929 until his death; astronomy, particularly meteors and variable stars; and photography, especially as applied to clouds and stars. At his request, his 3½-inch refractor will be given to the A.A.V.S.O.



Cepheus appears in as-Sufi's book dressed in Persian attire, causing the constellation figure to appear quite different from the more familiar Bayer figures. The Arabic star names also are shown.

AL-MULTAHIB

By George A. Davis, Jr.

Nor all unnamed shall rest the unfortunate
Family of Iasid Cepheus. For their name
Has come into the heavens since they were near
Akin to Zeus. Cepheus himself is set
Behind the Bear called Cynosura, and seems
Like one who stretches forth both hands.
—Aratus, *Phaenomena*, 179-183

ALTHOUGH the names of the stars and constellations have been carefully studied by scholars for many centuries, and the origins of the names have been pretty thoroughly determined, there remain a few cases where the researcher has not been able to write *finis* to his studies. Why the Arabs called the constellation Cepheus *al-Multahib*, "the burning or flaming one," seems to be one such unsolved riddle. As is usually the case where the answer is not perfectly obvious, guessing has been the order of the day, and, as I have remarked elsewhere[1] concerning the published origins of the names of some of the stars, "such conclusions speak loudly of the utter futility of guesswork in researches of this kind."

Christian Ludwig Ideler informs us that the name first appeared in the list of at-Tizini[2] in the 16th century, but as-Sufi had already used it in the 10th century as a well-known name of the constellation.[3] Ideler says, "The *Alphonsine Tables* and the Arabo-Latin *Almagest* add to Cepheus the attributes Inflammatus (inflamed) and Flammiger (fiery). This is the translation of the Arabic *al-Multahab* by which strange designation this constellation is mentioned by Tizini. I wonder whether it might come from the fact that the head of Cepheus stands in the Milky Way by which he likewise seems to be inflamed."[4]

Ideler, however, correctly regards as far-fetched the suggestion by Grotius[5] that the Arabs derived their title by translating the Greek word *pyrkaeus*, meaning "a fire-kindler," which, according to Pollux,[6] is found in the works of Aeschylus and Sophocles.

Richard Hinckley Allen followed a century later, in his *Star-Names and Their Meanings*, with a more plausible suggestion, but still missing the point, saying: "*Dominus solis* (master of the sun), *Flammiger*, *Inflammatus*, and *Incensus* (burning) are fiery epithets that do not seem appropriate for so faint a figure, unless originating from the fable that the tables of the Sun were spread in Aethiopia, the land where Cepheus reigned when on earth." And then, forgetting what Ideler had said, he continues naively: "Someone, however, has suggested that they are from the fact that his head is surrounded and illuminated by the Milky Way, although itself in an entirely bare spot in that great circle of light." Allen's further statement that "Arabian astronomers translated Inflammatus into *Al Multahab*" comes from a misunderstanding of the chronological order of events.

It must be remembered that Cepheus, the husband of Cassiopeia and the father of Andromeda, was the son of Belus and the king of Ethiopia.[7] He was a direct descendant of Io, whose father, according to one tradition, was Iasus, son of Argus—hence the epithet used by Aratus.[8] Although practically all writers on the constellations have stated that he was a member of the Argonautic expedition, this, of course, was not true, for *that* Cepheus was the son of Aleus, and *his* only claim to renown consisted in his disastrous support of Hercules in the latter's private war against Hippocoon and the Lacedaemonians.[9] There was also another Cepheus, son of Lycurgus, who took part in the famous Calydonian boar hunt.[10] And Lycophron[11] speaks of still another Cepheus who led the Achaeans on their journey from Troy to Cyprus, "land of the goddess queen of Golgi."

Since Cepheus was an Ethiopian, it is interesting to recall the remarks of Diodorus Siculus[12] concerning the origin of his people: "Now the Ethiopians, as historians relate, were the first of all men, and the proofs of this statement, they say, are manifest. For that they did not come into their land as immigrants from abroad but were natives of it and so justly bear the name of 'autochthones' is, they maintain, conceded by practically all men; furthermore, that those who dwell beneath the noonday sun were, in all likelihood, the first to be generated by the earth, is clear to all; since, inasmuch as it was the warmth of the sun which, at the generation of the universe, dried up the earth when it was still wet and impregnated it with life, it is reasonable to suppose that the region which was nearest the sun was the first to bring forth living creatures." And Ovid,[13] in his description of the conflagration of the earth attendant on Phaethon's attempt to drive the chariot of Helius, says that "it was then, as men think, that the peoples of Aethiopia became black-skinned, since the blood was drawn to the surface of their bodies by the heat."

Now the Greek name for an inhabitant of Ethiopia was and is *Aithiops*, "blazing" (the name, incidentally, of one of the horses of the Sun), from *aithein*, "to burn," and *ops*, "face," *i.e.*, one having a burnt or flaming face; and *al-Multahib*, therefore, turns out to be simply a translation of the Greek name for an Ethiopian! And it seems to me that Horace[14] must have had this or some similar thought in mind when he wrote: "Now Andromeda's shining father displays his fire which lay hid before," although we cannot be at all certain.[15]

While on the subject of Cepheus, I believe that another little matter will interest the student of the stars if he also happens to be a good observer. As-Sufi[16] mentions "a fairly large circle formed by stars between the stars *al-Firq* (which with him consisted of Alpha and Beta Cephei) and the three stars which are in the extremity of the right wing of the *Hen* (Theta, Iota, and Kappa Cygni). The Arabs call this circle *al-Qidr*." Qazwini also mentions it in his *Cosmography* as translated by Ideler. This "pot" or "cauldron" is composed of 11 stars, and, like several other asterisms of the Arabs, is much more apparent in the heavens than on star charts. *Al-Qidr* is visible on a particularly clear and

moonless night if one knows where to look for it, but, as the stars composing it have never to my knowledge been published by anyone, I give them here, with their magnitudes and spectra, to assist the observer in locating this attractive but somewhat elusive figure:

Theta Cephei, 4.28, *A5*; Eta Cephei, 3.59, *G7*; BS 7955 (Cep), 4.63, *F9*; BS 7860 (Cyg), 6.31, *K5*; BS 7827 (Cyg), 6.21, *A0*; 33 Cygni, 4.32, *A3*; 23 Cygni, 5.04, *B5*; BS 7448 (Dra), 6.43, *K5*; HD 185394 (Dra), 6.64, *K4*; 64 Draconis, 5.43, *M1*; and BS 7805 (Dra), 5.92, *K5*. (BS is the designation for the Yale *Catalogue of Bright Stars*.)

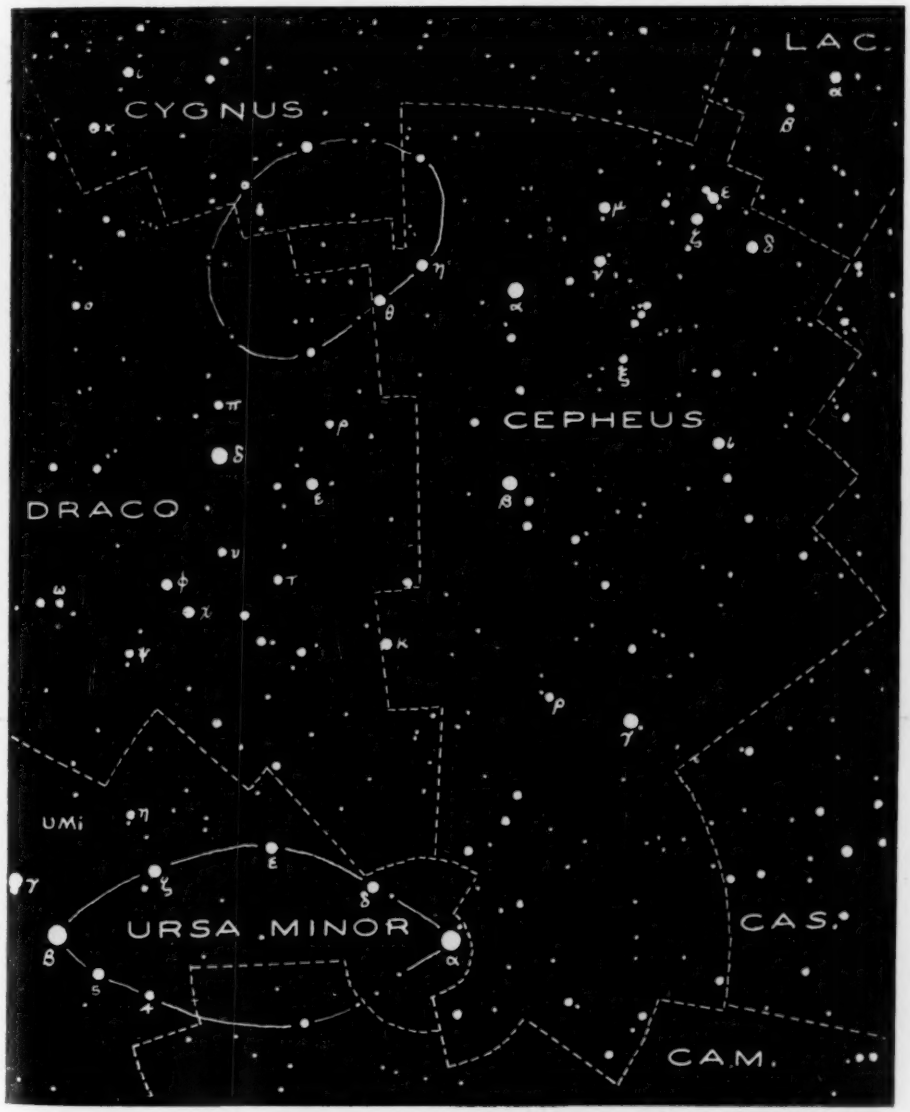
On the star chart below will be found the constellation Cepheus in its entirety, and stars of the surrounding constellations, with the boundaries as determined by the I.A.U. in 1930. The stellar disks represent a range of one whole magnitude, from 1.51 to 2.50, from 2.51 to 3.50, and so on.

Stars forming *al-Qidr* are connected by lines. The chart shows, too, another well-known Arabian asterism, mentioned by a learned Arabic commentator often referred to by Hyde, called *al-Ihlilij*,[17] the myrobalan tree. This will also be found interesting to the careful observer. It was so called because the stars are in the shape of the fruit of the tree which very much resembles a prune.

This asterism was also called *al-Fas*, a word which is said to mean a hole of some kind; and both as-Sufi and Qazwini[18] state that it was so named because of its resemblance to a part of a millstone, or "the hole or pan in which the mill-pinion revolves." The asterism is shaped roughly like a fish, similar to those two other fish in Perseus, Andromeda and Pisces.

The stars involved are easily recognized except the four in the western arc of the figure in Camelopardalis and Ursa Minor. Beginning with the star north preceding 4 Ursae Minoris, and continuing toward Polaris, they are as follows:

BS 4892-3 (Cam), 4.76, *A2*; BS 4606 (Cam), 6.38, *F5*; BS 4683 (UMi), 6.33, *F2*; and BS 4686 (UMi), 6.28, *F0*.



On this chart are plotted all stars brighter than 6.51 in the region of the constellation Cepheus, called by the Arabs "al-Multahib."

NOTES

1. *Popular Astronomy, LII*, 10, 1944.
2. Published in the original Arabic by Thomas Hyde in his *Syntagma Dissertationum*, Edition of 1767, Vol. 1; see particularly pages 95 and 96 under the names of Delta, Zeta, and Iota Cephei.
3. His great work on the stars and constellations was translated into French by H.C.F.C. Schjellerup in 1874 and published in St. Petersbourg under the title *Description des Etoiles Fixes;* see pages 60-63 for his discussion of Cepheus.
4. *Untersuchungen über den Ursprung und die Bedeutung der Sternnamen*, page 43; and see also the additional notes on pages 296 and 297.
5. *Syntagma Arateorum*, 46.
6. *Onamasticon*, IX. 156.
7. Apollodorus, *The Library*, II. 1. 4.
8. Apollodorus, *ibid.*, II. 1. 3.
9. Apollonius Rhodius, *Argonautica*, I. 20; Apollodorus, *ibid.*, I. 9. 16 and II. 7. 3; and Valerius Flaccus, *Argonautica*, I. 352.
11. *Alexandra*, 586, and *cf.* 447 ff.
12. *The Library of History*, III. 2. 1.
13. *Metamorphoses*, II. 235.
14. *Odes*, III. 29. 17.
15. The translations of Aratus, Diodorus, Ovid, Horace, and Lycophron are substantially those found in the *Loeb Classical Library*.
16. *Ibid.*, 62.
17. *Ibid.*, 13.
18. As-Sufi, *ibid.*, 45; and Ideler, *ibid.*, 3, 15-16.

OAKLAND AMATEUR ON HAWAII BUILDS TELESCOPE

A copy of *Hospital Hi-Lites*, publication of the U. S. Naval Hospital, Aiea Heights, T. H., has reached us via the son of Leon Campbell, recorder of the A.A.V.S.O. This is the issue of June 30th, and contains a photograph of Robert Pflager, PhM2c, and his 8-inch reflecting telescope, made during his spare time and being used by the patients and staff members at the hospital.

In the accompanying account of amateur Pflager's hobby, it is told how he became interested in astronomy while living in Portland, Ore. Then he moved to Oakland, Cal., where he built five reflectors while still in high school. He and Peter Valas undertook the grinding of a 24-inch mirror, but this work was interrupted by the war.

As a professor at the University of Hawaii had furnished the 8-inch kit for making the telescope mirror, it is possible that when he returns home Mr. Pflager will leave the instrument with that institution.

American Association of Variable Star Observers Meets

RETURN OF PEACE brought a number of A.A.V.S.O.'ers and their friends from more distant places, in addition to the nearby regulars who have been able to attend recent fall meetings at Harvard Observatory. The traditional joint meeting with the Bond Astronomical Club took place on Friday evening, October 5th. Dr. Fred L. Whipple, of Harvard, spoke on "Meteors and the Earth's Upper Atmosphere."

Early concepts of the upper atmosphere included the idea of constantly decreasing density and temperature with altitude, but recently it has been determined that inversions in temperature occur at several levels, with related changes in density and pressure. These revisions in our knowledge have resulted from radio experiments, analysis of auroral displays, and studies of meteors; the last were emphasized in Dr. Whipple's discussion. Of use also have been barographic studies of sound waves produced by the explosion of Krakatoa, the explosion of the Siberian meteorite in 1908, and the blowing up of ammunition dumps at the close of World War I.

Meteor photography, especially where the same meteor is "caught" from two different stations, can give a meteor's brightness, its height and speed, its deceleration, its orbit; and data on the upper atmosphere is a by-product of this astronomical investigation. Dr. Whipple believes that with the new wide-angle lenses, pairs of meteor plates may be secured by the hundreds instead of by ones or tens, and these will give us more precise information on the upper atmosphere.

Saturday morning's business meeting was highlighted by the 14th annual report of the recorder, Leon Campbell, in which he summarized activities of the A.A.V.S.O. for the past year. An encouraging note is the increased number of observations from abroad, with South Africa, Canada, South America, India, Australia, Mexico, and Ireland contributing, in that order, to the number of observations received during the year 1944-45. C. F. Fernald, of Wilton, Me., again heads the list of observers, with 7,216 observations—a new high for any one observer in any one year. To achieve this, he spent 180 hours observing on 173 nights, or about an hour every other night through the year. An average of 40 estimates per hour attests the speed and accuracy with which Mr. Fernald observes.

The report of the aurora committee from its chairman, E. A. Halbach, of Milwaukee, mentioned the enforced inactivity of this committee in recent years, and pointed out the importance of being prepared well in advance of the next sunspot maximum, predicted for 1948 or 1949. Announcement was made of the extension of this committee through 1950. Aurora observers are needed throughout the country, with a reasonably good northern horizon as one of the few requisites. The occultations committee also needs serious observers; for this work a telescope is necessary, and means for getting time accurate to at least one second.

The report of the solar division, new section of the association organized about a year ago, supplemented the report presented at the council meeting in June. This group of observers of our daytime variable star, under the direction of Neil J. Heines, of Paterson, N. J., was originally formed to provide needed data on the sun for wartime uses, but the work is continuing to be of value. Observations made by the 62 members of the division have been reduced by the Department of Terrestrial Magnetism of the Carnegie Institution at Washington, D. C. Several observers are making special records of the sun's granulation, and a proposed project includes studies of solar spicules. Nearly 6,000 individual observations of the sun have been made by this group since the inception of the division a year ago.

New councilors elected at the morning meeting are Lewis J. Boss, Providence, R.I., re-elected; Ralph N. Buckstaff, of Oshkosh, Wis.; Mr. Heines; and Dr. W. L. Holt, of Amherst, Mass. The date of the 1946 spring meeting of the A.A.V.S.O., the first to be held in several years, is not yet definitely announced, although the invitation of Miss Marjorie Williams to meet at Smith College was accepted.

New officers elected by the council are Dr. Charles H. Smiley, Ladd Observatory, president; Miss Williams, 1st vice-president; David W. Rosebrugh, Waterbury, Conn., 2nd vice-president (Mr. Rosebrugh has for nine years been the efficient and hard-working secretary of the association); Herbert M. Harris, South Portland, Me., secretary. Re-elected for another year were Mr. Campbell, recorder, and Percy W. Witherell, Jamaica Plain, Mass., treasurer.

Six papers were presented at the afternoon session. H. H. Clayton, of Canton, Mass., who is a well-known weather expert and author of several treatises on the subject, discussed "Solar and Weather Changes." He showed lantern slides of correlations between sunspots and terrestrial weather conditions. Defining a cold wave as a drop in temperature of 20 degrees or more, he showed that on a number of occasions cold waves followed by several days the sudden appearance of spots on the sun. Spring and summer are the seasons when the correlations in weather and sunspots are most marked. Studies of pressure-sunspot data reveal a latitude effect, with stations nearer the equator having an inverse relation and high-latitude stations showing a direct relation. Theory could explain this on the basis of increased heating of the earth by the sun at the time of a spot outburst. Therefore, when sunspots increase, the excess of pressure is moved toward higher latitudes, the expansion at the equator giving the observed lower barometric readings and heavy pressure toward the poles resulting in the higher readings.

The problem of unexplained differences in magnitude estimates made with different instruments was discussed by Mr. Rosebrugh. At a recent minimum of R Coronae Borealis, when the light changes could not be definitely anticipated on the basis of prior experience, he made estimates with a 4-inch, 30x refractor and a pair of 15x60 binoculars. The binocular magnitudes were brighter, with a steadily increasing difference in the estimates through minimum, but with the curves again drawing closer together as the star returned to normal brightness.

Joseph Ashbrook, of Harvard, has looked into the history of an unusual nova which appeared in Vulpecula in 1670. He has used recorded magnitude estimates to plot the star's light curve, with the result that it appears to have had two maxima, one in July, 1670, a month after its discovery, and another in March of the following year. These maxima are of about equal height, around magnitude 2.5, and between them the star faded below naked-eye visibility (no telescope observations are on record). While these changes have a slight similarity to those of Nova Herculis and Nova Pictoris, the original slow rise to maximum, the length of time between outbursts, and the low brightness between them, all make Nova Vulpeculae 1670 different from these modern novae. To date the star has not been identified among those now charted in this region.

James J. Neale, of New Haven, Conn., described his observations of a twilight occultation at the bright limb of the moon. As had been expected, the troublesome glow around the bright limb was so reduced by the general sky illumination half an hour

before sunrise that accurate timing of the occultation could be made. On July 7th, with the 9-inch Reed refractor at Yale Observatory, Mr. Neale observed the near-grazing occultation of 1 Tauri, magnitude 5.3. The glow appeared several times as wide as the star image, but the latter was so bright in comparison that the star was easily seen right up to the limb, and then its disappearance was sharp and clean-cut, just as with immersions at the dark limb. Mr. Neale suggested that observers add such twilight events to their lists, thereby increasing the number of occultations available for timing.

A review of photometric observations made of the falling shadow at the July 9th eclipse was presented by James Stokley, of the General Electric Company, who observed at Malta, Mont., with Dr. John Q. Stewart, of Princeton. Although totality was successfully witnessed by this party, clouds in other parts of the sky make the overall results of the observing program of doubtful value.

Dr. James C. Bartlett, of Baltimore, Md., has been observing the sun to determine variations in the presence of granulation or "rice-grain" structure of the photosphere. In a paper presented *in absentia*, Dr. Bartlett reports on observations with a 2-inch refractor extending from 1940 to the present. There appears to be a correlation between granulation and sunspot activity, but local temperature conditions do not appear to affect the visibility of the granules.

Mr. Fernald described what he considers an ideal observing instrument, based on his eight years of experience with an 8-inch Springfield-mounted reflector. He suggests as most desirable two instruments of this type, one a 6-inch f/6.5 and the other a 10-inch f/7.5. The latter should be motor driven, with slip-ring right ascension circle and removable mirror cell. A heating element on the eyepiece is very valuable and "comfortable in cold weather." This assiduous observer proposes that the three main parts of such instruments be cast in more-or-less mass production by a manufacturer, and that local foundries could provide the smaller parts of such mounts to individual specifications.

Tea was served by the observatory staff at the conclusion of the afternoon session, and the evening dinner at the Harvard Faculty Club concluded this first peacetime meeting of the American Association of Variable Star Observers. The number of members present and the variety of papers indicate that a new period of amateur astronomical activity has begun.

H.S.F.

Amateur Astronomers

THIS MONTH'S LECTURES

Boston: Dr. J. L. Comrie, of the Scientific Computing Service, London, and formerly director of the British Nautical Almanac Office, will speak to the Bond Astronomical Club on "Numerical Aids of Astronomy." The lecture will be on November 1st, Thursday, at 8:15, at the Harvard College Observatory in Cambridge.

Chicago: A general discussion on the November evening sky, conducted by J. M. Showalter, will open the meeting of the Burnham Astronomical Society on Tuesday, November 13th. Professor Clarence R. Smith, Aurora College, will give the principal lecture, on "Sherburne Wesley Burnham, Master Double Star Observer." The annual meeting of members, for election of officers and directors, will close the program. The meeting is at the Chicago Academy of Sciences auditorium, at 8:00 p.m.

Cincinnati: "The Moons of Jupiter" will be discussed by Dr. Paul Herget, director of the Cincinnati University Observatory, at the November 9th meeting of the Cincinnati Astronomical Association. The group meets at the Cincinnati Observatory at 8:00 p.m.

Cleveland: On November 9th, at 8:00 p.m., Dr. Leo Goldberg, of the McMath-Hulbert Observatory, will address the Cleveland Astronomical Society on "Gaseous Nebulae." The meeting is at the Warner and Swasey Observatory, East Cleveland.

Detroit: At the Sunday, November 11th, meeting of the Detroit Astronomical Society, William Schultz, Jr., of the Cranbrook School and Cranbrook Institute of Science, will give an address with sound moving pictures on "Electronics." The meeting is at Wayne University at 3 o'clock.

Indianapolis: "Meteors" is the subject of the lecture by Emsley W. Johnson to the Indiana Astronomical Society on November 4th, Sunday, at 2:15 p.m., in Odeon Hall.

Madison: Following a 10-minute discussion of the constellation Perseus, sound motion pictures on "Exploring the Universe," "The Solar System," and "The Moon," will be shown at the November 14th meeting of the Madison Astronomical Society. The meeting is at Washburn Observatory, Wednesday evening at 8:00 p.m.

New York: "Atomic Energy" is the title of the lecture before the Amateur Astronomers Association by Howard W. Blakeslee, science editor of the Associated Press, on November 7th, Wednesday, at 8 o'clock. The meeting is in the Roosevelt Memorial building of the American Museum of Natural History.

Washington, D.C.: At the meeting of the National Capital Amateur Astronomers Association in November, Dr. M. W. Sterling, of the Smithsonian Institution, will lecture on "The Middle American Calendar." The meeting is at the National Museum on November 3rd, Saturday, at 8:00.

CLEVELAND PUBLIC NIGHTS

As in the past, public nights will be held on stated Thursday and Friday evenings each month through June at the Warner and Swasey Observatory, East Cleveland, Ohio. A new lecture is presented each month. For reservations, call the Case School of Applied Science, GArfield 6680.

ROYAL ASTRONOMICAL SOCIETY OF CANADA

We are glad to quote an announcement received from the R.A.S.C., with regard to astronomical activities north of the border.

"This society was incorporated in 1890 under the name of The Astronomical and Physical Society of Toronto, and assumed its present name in 1903. The society has active Centres in Quebec and Montreal, P.Q.; Ottawa, Toronto, Hamilton, London, and Windsor, Ont.; Winnipeg, Man.; Edmonton and Calgary, Alta.; Vancouver and Victoria, B.C.

"The society publishes a monthly *Journal* containing each year about 500 pages, and a yearly *Observer's Handbook* of about 80 pages. The *Journal* contains articles on recent developments in astronomy and astrophysics. The *Handbook*, revised yearly, supplies the observer and student with necessary information on the fundamentals of the science. These publications are free to members, and to others are 25 cents each.

"The society also maintains a library at 198 College St., Toronto, for the use of members.

"Lectures, meetings and opportunities for telescope observation are held regularly at all the Centres. Membership is open to anyone interested in astronomy. Annual fee, $2.00. Apply to The General Secretary, R.A.S.C., 198 College St., Toronto."

In 1858, Donati's comet passed over the star Arcturus, which is, presumably, shown close to the comet's head in this drawing of the comet as seen over London.

COMETS AND M

By MARIAN LOCKWOOD, *Hayden Planet*

Some of the most spectacular phenomena of the sky a... ghosts of space, comets and meteors. Past fancy a... facts regarding these mysterious members of the solar ... here and in the Hayden Planetarium this ...

That wise and happy man will never fear
The evil aspect of the year;
Nor tremble, though two comets should appear.
—Horace, *The Profane*, translated from the Latin by Abraham Cowley

THROUGHOUT the centuries, even to the present so-called enlightened age, men have feared and trembled at the appearance of a comet in the sky. Today, it is true, only those who have no scientific background whatever believe that comets are the sources of plague and pestilence, evil and destruction. To obtain a general idea of popular superstitions concerning these beautiful bodies, we repeat a statement made by Chambers in his interesting *Book of Days*, published in 1864:

"Halley's Comet, so-called, has been the means of dispelling many popular illusions concerning the influence of those mysterious bodies on worldly affairs. Before it had been ascertained that comets are periodical in their appearance, there was unbounded scope for speculation on the nature of this influence. The excellence of the celebrated vintage of 1811 was attributed to the great comet which appeared in that year; as was also the abundance of the crops. Nay, the number of twins born in the same year, and the fact that a shoemaker's wife in Whitechapel had four children at a birth, were in like manner laid to the charge of the comet; as likewise were the facts that wasps were few, and that flies became blind that year. The Great Plague of London was attributed by some to a comet. . . . A church clock, destroyed by a meteoric stone; an unusually large flock of wild pigeons in America; the disasters which were experienced by the Christians at the hands of the Turks in 1456; a fit of sneezing that became very prevalent in some parts of Germany; the deaths of eminent persons in various countries—all were believed to have been either produced or presaged by comets which appeared in certain years. That of two things which occurred nearly at the same time, one is the *cause* of the other, is a very popular and easy mode of philosophising. M. Arago adduces, in illustration of this point, the anecdote told by Bayle, of a lady who never looked out of the window of her apartment, situated in the greatest thoroughfare of Paris, and saw the street filled with carriages, without imagining that her appearance at the window was the cause of the crowd!"

Comets and meteors both belong to the sun's family, as do the earth and other planets. In spite of the popular confusion as to the respective characteristics of these types of bodies, however, comets and meteors are not alike. When the eager observer notices a quick, bright flash of light across the sky, disappearing almost as soon as it is seen, he has not observed a comet, but a meteor or "shooting star." Comets appear to move with great dignity across the sky, and are visible for many nights, weeks, or even months.

The word comet is derived from the Latin word meaning "hair," because of the long and brilliant tails which so many bodies of this type develop in the course of their travels around the sun. The average comet consists of a bright nebulous head known as the coma, often containing a small brilliant center, the nucleus, and the tail, which may be millions of miles in length. The tail of the Great Comet of 1843, longest on record, stretched across space more than twice the distance from the earth to the sun, or nearly two hundred million miles.

The head of a comet consists of gas, with very fine dust intermingled, and a mass of meteoric particles, many of them of considerable size, but all widely separated. According to the most recent estimates, none of the meteoric particles in the nucleus exceeds a diameter of from one to two kilometers, or from 3,000 to 6,000 feet. In the interesting discussion of comets in his book *Between the Planets*, Dr. Fletcher G. Watson points out that when in 1910 Halley's comet passed directly between earth and sun, "not the slightest shadow of the comet could be seen against the sun's disk; a solid body fifty kilometers across would have appeared as a small dot moving across the sun." (See the back cover for a photograph of Halley's comet.)

The tail of a comet is composed of gas and minute dust particles, and is extremely thin and nebulous. At great distances from the sun a comet consists only of the coma or head, but as the comet approaches the solar body, the tail begins to develop, becoming brighter and more extensive as its nearness to the sun increases. Not all comets, however, develop tails.

One of the most interesting aspects of comet study is the recognition that the tail of a comet, once formed, always points away from the sun. As the comet moves in nearer the sun, the tail swings around so that when the comet leaves the sun's neighborhood, the tail precedes the head. Approaching the sun, the tail follows the head, which seems a more usual state of affairs. The direction of the tail relative to the sun is easily understood when it is recognized that the cause of the tail's formation is the pressure of sunlight upon dust and gas ejected by the head.

Formerly it was believed that some comets, as they moved in their elongated orbits around the sun, came in from the outer regions of the universe, perhaps having originated in interstellar space. Because of the difficulty of exactly determining the shape of the orbit from the small portion the comet traverses while it is visible to us, it was thought that many comets moved in open curves, passing once around the sun, but never again visiting its neighborhood. Today the general consensus of opinion is that probably all comets belong to the solar

METEORS

Planets

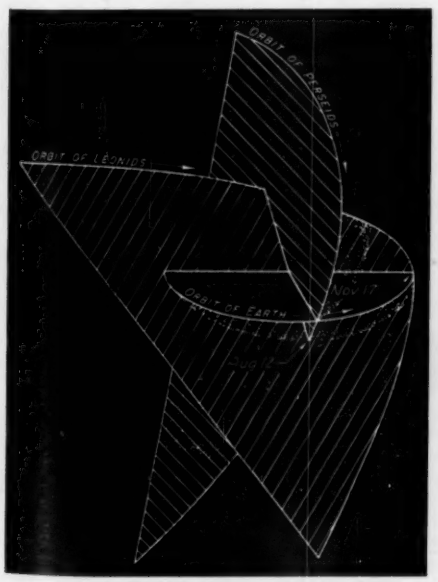
e sky produced by the ancy apparently known solar system are discussed m this issue.

system, even though many of them move in such long orbits that their periodic returns are separated by thousands of years.

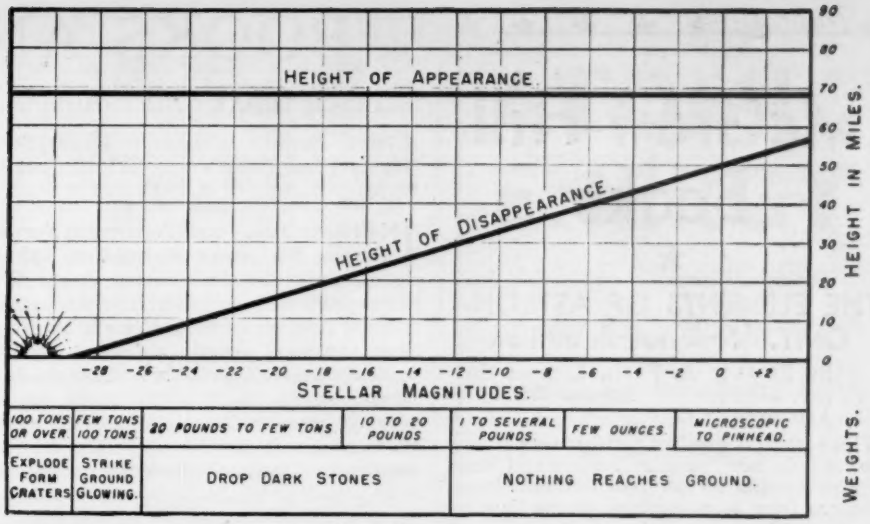
As to the origin of these interesting bodies, there are many theories, but the truth is still a mystery which remains almost as dark and unfathomable as it was in the days of Galileo. The statement is sometimes made that comets are part of the general debris left over after the formation of the solar system, but since we have no very clear idea as to how the solar system was formed, this leaves us still in the dark.

One of the fascinating aspects of comet hunting is that one can never tell when a new and hitherto unobserved comet will make its appearance. Since some comets have periods of thousands of years, there may be many brilliant ones which have not been seen in scientific times. The comet with the shortest period known is Encke's comet, which travels around the sun once in every 3.3 years. There are many comets with periods of less than 10 years.

While there is nothing more beautiful than a great comet, meteors might be thought to hold more fascination



The intersections of the orbit of the earth with the orbits of the August and November meteor swarms are shown here. From "Astronomy, Maps, and Weather," by C. C. Wylie.



This chart correlates with other characteristics the heights of appearance and disappearance of meteors of all brightnesses and sizes. From "Astronomy, Maps, and Weather," by C. C. Wylie.

for the amateur observer, since they are much more numerous and easier to observe. No clear night passes without the appearance of at least a few meteors, and on some nights many hundreds can be counted by a tireless observer.

Meteors are called "shooting" or "falling" stars because as they streak through the earth's atmosphere, glowing because of the friction with the air, they resemble stars falling out of the sky. In actual nature, however, they differ as much as possible from stellar bodies. Meteors are, ordinarily, very tiny bodies which are moving in swarms or rings around the sun, possibly leftovers from the creation of the solar system—material which was not gathered up in the forming of the planets and the satellites. The average meteor is not larger than a grain of sand, although some exceptional ones weigh many tons. In the sky such a body is usually referred to as a meteor, but after it lands on the earth it becomes a meteorite.

Meteorites are of two general types, the stony meteorites and the irons. It is believed that more stony ones fall, but by far the greater number of those seen in museums are of the iron variety because they are much easier to identify. Iron meteorites exhibit a peculiar crystalline structure which under ordinary circumstances is not found in terrestrial iron—when etched with nitric acid, this structure produces a characteristic pattern of Widmanstaetten lines.

Meteors are divided into those which appear sporadically and those which are part of meteor showers. At regular times during the year, the earth's path crosses the paths of meteor swarms (moving in their own orbits around the sun); if the earth is at such an intersection, we observe a meteor shower, when hundreds of these objects may be seen in a single night. Among the most famous and brilliant of these showers are the Leonids and the Perseids, the former, a November occurrence, appearing to radiate from the constellation of Leo, and the latter, in August, from Perseus. According to the best and most recent estimates, many billions of meteors enter the earth's atmosphere every 24 hours, although most of these are so faint as not to be visible to the unaided eye.

The largest meteorite in any collection is the great Ahnighito, an iron weighing about 36½ tons, which is to be seen in the first floor ambulatory of the Hayden Planetarium in New York City. This is one of the several brought back from Greenland by Peary many years ago.

While at first glance there might seem to be no connection between comets and meteors, astronomers are certain that such a connection does exist. In some instances, after a comet has returned again and again to the neighborhood of the sun, it seems to disintegrate, probably no longer able to stand the tremendous pull exerted upon it by the sun. In such cases, showers of meteors have appeared in the same orbits and at the same times as the former comet. And there are other cases of meteor showers from meteors scattered along the paths of comets which are still very active, such as Halley's. The Eta Aquarids, in May, and the October Orionids provide the interesting case of a double shower associated with Halley's comet.

Whatever the answer to the question of their mysterious origins, there are few heavenly bodies which yield so much treasure to the adventuring amateur astronomer as comets and meteors.

Ask me no more where those stars light
That downward fall in dead of night.
—Thomas Carew

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BOOKS AND THE SKY

SCIENCE TODAY AND TOMORROW

Second Series. **Waldemar Kaempffert.** Viking Press, New York, 1945. 279 pages. $2.75.

IN **Science Today and Tomorrow,** Second Series, Waldemar Kaempffert brings up to date the first series under this title, published in 1939. The 24 essays include four on aspects of medicine, four that are most readily classified as biological, three on physics, one on meteorology, seven on general problems of science and civilization, and five on astronomy. It is with these last five, of course, that we are principally concerned.

The first of these is entitled "The Sun: New Aspects," and discusses sunspots at some length, and then the source of the sun's energy, most of the information coming from Jeans. Some reference is also made to radiation pressure, loss of mass, and the cold-death of mankind and of the earth in the future. To balance this, however, the heat-death of mankind is described in the following essay, entitled "A Star Explodes," which deals with novae. "Life in the Solar System" briefly presents Jeans' hypothesis of the formation of the solar system, then discusses each planet as a possible abode of life, present, past, or future. "Rocketing Through Space" explains the theory of the rocket, then continues the argument of the previous essay by suggesting that Venus may be colonized by man when the earth cools too far. In "Birth and Death of the Moon," Mr. Kaempffert assumes the fission theory of the moon's origin, and presents briefly the tidal episodes of recession, approach, disruption, and collision with the earth.

The quality of these essays is indeed noteworthy. Covering as they do all fields of science, it would be not in the least surprising to detect many errors, yet although the reviewer differs with Mr. Kaempffert in several points of philosophical interpretation, and in a few other matters which are currently a matter of dispute in scientific circles, he has noticed no instance of factual error in the whole volume. The book is also pleasantly free of the uncomprehending paraphrasing of a scientist's own words, a fault not unknown in the field of science reporting in which Mr. Kaempffert is so scintillating a luminary. The accomplishment is the more remarkable since the writing is intended for a completely non-scientific reader. Imagine discussing the collapse theory of novae, and pausing to explain what is meant by stellar magnitude!

It is also interesting to see how the book exemplifies the rapidity of the current onrush of science. If its publication had been delayed only a few months, the author would doubtless have added an essay on atomic power, for the development of the atomic bomb has highlighted this aspect of modern science to the point where the two references to this subject seem totally inadequate. So rapidly does our picture of the universe alter!

L. J. LAFLEUR
Antioch College

PICTURE BOOK OF ASTRONOMY

Jerome S. Meyer, illustrated by Richard Floethe. Lothrop, Lee and Shepard Co., New York, 1945. 36 pages. $1.75.

THE SIX-TO-TEN-YEAR GROUP, for which this book is intended, is very ready to absorb and appreciate astronomical information, and there are not many books that fill the need. Such a volume should be a picture book, of course, and for this age group it should deal rather in facts than in concepts.

Mr. Meyer's book begins with an account of the earth and gravity, passes to the sun and the planets. The latter, especially Mars, are described with imaginative detail. Six pages on the stars conclude the book. The factual basis of the text, though correct, occupies too small a part of the book. The flights of fancy are probably within the realms of legitimate speculation—for example, the visits to the moon and Jupiter, and especially the trip by rocket ship to Mars—but they put the emphasis in the wrong place. A book of this kind may well be a child's first introduction to scientific knowledge, and it is a pity that he might receive the impression that this knowledge is full of fancy.

A scientist finds matter for criticism in the illustrations. Those that are

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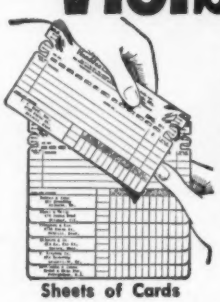
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primarily of human interest have an amusing charm, but purely scientific subjects do not lend themselves to this treatment. The picture of the sun would shock any astrophysicist — the artist might better have based his presentation on one of many beautiful eclipse pictures. The Martian landscape, also, with no factual foundation at all, would have been better omitted. Why, if a spectacular picture was desired, was nothing whatever said about the wonder of the solar system, Saturn, with its fantastic rings? There is a well-known imaginative picture of the rings of Saturn, as seen from one of the satellites, which might have been used as the basis of a striking illustration.

This reviewer believes, however, that no creation of an artist can compete in power and impressiveness with some of the modern photographs of astronomical objects. It is a mistake to suppose that a child cannot appreciate photographs of the Milky Way, of the nebulae, and of distant star clusters and galaxies. Although they embrace most of modern astronomy, the aspects of astronomy opened up by these subjects are beyond the scope of the present book.

The reactions of several children to the **Picture Book of Astronomy** have been favorable, but not enthusiastic. Some found the rocket ship rather terrifying, and one of them (they were possibly biased as being the children of astronomers) commented that the book told him everything he knew already and nothing that he wanted to know.

This is a pleasant book for one reading, but not for a constant companion. To childrens' libraries it should have a real appeal.

CECILIA PAYNE-GAPOSCHKIN
Harvard College Observatory

NEW BOOKS RECEIVED

Optical Instruments, *Earle B. Brown*, 1945, *Chemical*. 567 *pages*. $10.00.

The editor of *Sky and Telescope's* Gleanings for A.T.M.'s department has spent several years in the Ordnance Branch of the U.S. Army, where he has for a good part of the time been engaged in teaching optics and the design and use of military optical instruments. He has consequently been able to understand the requirements for a book on the general theory, design, and maintenance of optical instruments of all kinds, and to include therein much material on telescopes and other instruments, useful to the amateur astronomer.

Atomic Energy in the Coming Era, *David Dietz*, 1945, *Dodd, Mead*. 184 *pages*. $2.00.

The science editor of the Scripps-Howard newspapers, and well-known organizer of the annual Cleveland public star parties, has written a comprehensive story of nuclear physics. The book contains several unusual diagrams and photographs.

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The INDEX for Volume IV

is in preparation. It will be similar to previous indexes, including title page, author, title, subject, and topic references. Send 25 cents, and your copy will be mailed as soon as printing is completed.

Sky Publishing Corporation
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Foreword by James G. Baker of Harvard Observatory

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OBSERVER'S PAGE

All times mentioned on the Observer's Page are Eastern standard time.

Color Sequences in Lunar Eclipses

AN OBSERVATION of a total eclipse of the sun ordinarily involves extended travel and painstaking preparations brought to the sharp focus of a few fleet moments confined to very exact and limited areas; but a total eclipse of the moon may be watched and studied leisurely over the length and breadth of an entire continent.

The earth's sweeping nocturnal shadow extends into space for 857,000 miles as it fades out in a tapering spire; and when the moon passes full through the shadow's center, at her average distance of 238,000 miles, our satellite travels 5,700 miles during the entire duration of an eclipse.

When we see a lunar eclipse, we are also viewing a solar eclipse in reverse. The lunar gaze beholds a huge disk of black shutting off the sun, but this disk is rimmed with a spectrum produced by the passage of sunlight through the earth's atmosphere. Light rays in transit across the illumined circle of the earth's rim are captured by the atmosphere and refracted and scattered inward, where they fall upon those portions of the moon which would otherwise be in shadow; there results the variegated colors we see on the moon while it is in eclipse.

The luminous circle surrounding the nocturnal hemisphere of the earth is the line of sunrise and sunset—the circle of dusk and dawn. But the earth's rotation constantly moves this circle over the earth, producing changes of scenery—a kaleidoscopic blend of colors of blushing dawn and magic sunset, all transferred to and reflected from the darkened moon. Mountains, valleys, oceans and prairies, forests and snow fields, clear skies and cloudy, polar ice floes, these affect the fountainhead of the colors that drift so delicately across the moon's countenance when she is in eclipse.

In the rarefied atmosphere of high terrestrial altitudes, we should get closer to the true colors reflected by the moon —nearer to observing a perfect portrayal of the actual results of sunlight passing through the earth's atmosphere. Sea-level observers are more apt to discern colors modified by once again traversing the dense and turbulent regions close to the earth's surface. More variety and more striking color effects should be observed from low altitudes, though clearer and more distinct in their delineations when seen from lofty places.

In anticipation of the lunar eclipse which will be visible over all of North America on December 18th, the following observations may be of value for comparison with the coming event. At this season, the prevalence of bad weather in many parts of the United States makes it advisable that observers watch from as many places as possible. Color and shadow chartings can be made and results cleared through **Sky and Telescope.**

The writer has evolved a simple system for charting lunar eclipse color and shadow phenomena. Plain white index cards of any size from 3x5 to 5x8 inches can be used on both sides—12 cards provide 24 marking panels. In the center of each card draw a quartered circle; place an arrow in the upright position; and indicate spaces for marking the time when the dominant changes take place and the succession in which they occur. Let the markings and recordings follow definite changes of shadow and color.

The total lunar eclipse of July 15, 1935, was observed from about 1,400 feet near Auburn, Cal., in the Sierra foothills. The eclipse began at 7:12 p.m., shortly after moonrise, and it was nearly an hour before the moon cleared low-lying clouds. Totality extended from 8:09 to 9:50, and last contact was at 10:47.

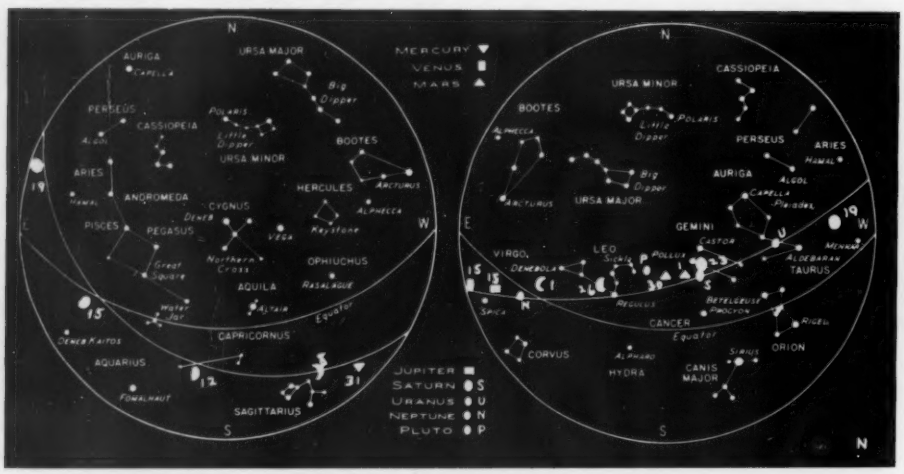
The first colors to appear, indistinct casts of slate blue, became stronger until pale blood red, extending from the cusps of the crescent, filtered inward upon the disk, turning the entire eclipsed area into a perfect blend of reddish blue which deepened rapidly. Then the red became dominant.

The beginning of totality presented a moon of pale blood red still slightly tinged with blue and with its facial features fairly visible in the more delicately shaded areas. The red darkened to a deep smoke red at mid-totality. As totality began to recede, the red lightened rapidly and the left rim soon took on a whitish red which became almost luminescent, and the lunar features were once more visible.

At the end of totality, the pale smoke red changed to smoke pink and then pearl pink after the tiny crescent of direct sunlight emerged from the left rim. This moment, with the lunar features clear and visible, brought the most beautiful aspect in the later phases of the eclipse. The remainder of the eclipse was a repetition of the first part, in reverse.

Simultaneously with the Auburn observations, Mildred Butler, of Burlingame, Cal., observed in a clear and cloudless sky from an open field near the tide

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 5:30 a.m. on the 7th of the month, and at 4:30 a.m. on the 23rd. At the left is the sky for 5:30 p.m. on the 7th and for 4:30 p.m. on the 23rd. The moon's position is given for certain dates by symbols which show roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury is in the evening sky during the entire month, reaching greatest elongation east on the 17th, 22½° from the sun, and setting about an hour later than the sun.

Venus is getting less conspicuous in the morning sky, rising less than two hours ahead of the sun at the beginning of the month. On the 6th, the bright planet passes 3° north of Spica.

Mars is occulted by the moon on November 23-24; for observers in the northeastern states the emersion is visible. For others, this is a close conjunction. Mars and Saturn, somewhat similar in appearance, form interesting patterns with Castor and Pollux.

Jupiter, in Virgo, is becoming more conspicuous in the morning sky, rising several hours ahead of the sun.

Saturn, in Gemini, begins its retrograde motion on November 6th.

Uranus is in Taurus; **Neptune** is in Virgo; **Pluto** is in Cancer.

PLUTO POSITIONS

An ephemeris for Pluto covering the current opposition, and running from November 1st through March 9, 1946, has been prepared by Dr. G. M. Clemence, of the U. S. Naval Observatory. If amateurs with large instruments wish this information, we shall be glad to furnish it upon request.

flats 18 miles south of San Francisco. Her recordings, given partially below, show the marked variations between sea level and 1,400 feet, plus a distance of about 150 miles.

At 7:35 the crescent rim shone with a bright orange pink softened inward over one third of the disk, and the remaining two thirds was a dark sky blue. Then the rim became a bright yellow, with the deep blue covering 5/6 the total area. Shortly, the first faint tinges of rose permeated the blue, but the remaining crescent area continued as a bright yellow. Near totality, this yellow was retained by the tiny sliver of luminosity. At complete totality, the yellow faded with the enshadowed areas unchanged.

Within eight minutes, most of the right hemisphere had cleared of shadow, revealing mixed pale rose and yellow, which soon were reduced to the lower right edge as the remaining whole became completely enshadowed. At 8:50, all the darkness was well-centered vertically upon the moon's disk, with the outer parts of both hemispheres disclosing bright shades of reddish yellow; and with a further contraction of the dark field, at the center of totality, 9 p.m., all the outer areas of the moon presented a clear and definite cast of red.

Due to an unpredictable chill wind arising from the bay, these observations were not carried through third and fourth contacts, but it may be assumed that the variety and richness of coloration which marked these sea-level effects appeared once again in reverse order.

At the total eclipse of May 13-14, 1938, observations were made from Summit Valley near Donner Pass, 7,000 feet high in the Sierras. Totality extended from 12:18 a.m. to 1:09 a.m. The midnight sky was clear, and delicate veils of cirrus but slightly dimmed the stars.

Colors began with deep tones of slate blue which became lighter and suffused with dull pink and pale red. As the obscuration advanced, the slate blue was replaced gradually by the reds, which reached their maximum depth near the heavily shaded central area during the climax of totality. But even as the moon shone as a gleamless orb of pale dull red, the lower rim became so light that the facial outlines were revealed clearly and distinctly.

The emerging lunar disk went through the reversed sequence of colors; slate blue marked the beginning and ending of the eclipse, but the dominant colors were varying shades of red. Depth and brilliancy of colors were not so marked as those revealed in the two observations taken at much lower altitudes at the earlier eclipse. Apparently the short wave lengths—violets and blues—are lost by scattering in transit through the earth's atmosphere, so that near sea level yellows and reds predominate during most of an eclipse. Definite and clear shades of green are rare, and usually they are seen only in high temperate latitudes and from the polar regions.

Aside from an appreciation of the purely esthetic values of cosmic beauty, a contribution to astronomical science may result from careful observations of the totally eclipsed moon, especially if these can be correlated with weather and other conditions in the atmosphere prevailing during the eclipse along the twilight rim of the earth.

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PHASES OF THE MOON

New moon	November 4,	6:11 p.m.
First quarter	November 12,	6:34 p.m.
Full moon	November 19,	10:13 a.m.
Last quarter	November 26,	8:28 a.m.

LEONIDS

The Leonid meteor shower is scheduled to reach maximum activity on the 15th and 16th of November. Leonids are among the fastest moving of shower meteors, and a number of them may usually be counted on to leave trains.

MINIMA OF ALGOL

November 1, 3:25 a.m.; 4, 0:14 a.m.; 6, 9:02 p.m.; 21, 5:07 a.m.; 24, 1:56 a.m.; 26, 10:45 p.m.; 29, 7:34 p.m.

ANTI-SOLAR RAYS

Crepuscular rays are frequently observed diverging from the sun, usually in the partly cloudy and humid atmosphere following a storm. Less common are anti-crepuscular or anti-solar rays, the subject of an inquiry from Lt. R. M. Evans, j.g., of the U.S.S. Holland, recently stationed at Guam. His letter was referred to Dr. Charles F. Brooks, of Blue Hill Meteorological Observatory, who replied as follows:

"These rays that cross the sky and converge opposite the sun do so because, being essentially parallel, they appear to meet in the distance. They look curved because they are projected against the dome of the sky. The conditions for their formation at Guam would indeed be excellent, for, as you say, the sunset is usually broken up by towering cumulus clouds, which, being very dense and sharply outlined, make a contrast between the dark shaded bands and the illuminated sky. If it weren't for the shadow, you would have the complete dome of the sky lighted up as usual in the sunset on a clear evening. The light is simply reflected from the molecules of air and particles in the atmosphere and is most pronounced under hazy conditions. In the marine tropics, of course, the salt dust haze due to moisture collected on hygroscopic saline nuclei very readily returns part of any illumination that falls upon it. This makes the contrast between the lighted and darkened portions of the sky more prominent.

OCCULTATION PREDICTIONS FOR NOVEMBER

12-13 **Kappa Capricorni** 4.8, 21:39.7 —19-07.1, 8, +71° +13° Im: **A** 1:45.0 —3.0 —3.9 131°; **B** 1:34.2 —2.0 —2.0 114°; **C** 1:44.4 . . . . . 136°; **D** 1:25.4 —2.2 —1.6 109°; **E** 1:02.8 —2.4 —0.6 97°; **F** 0:50.5 —3.4 —1.1 112°; **H** 23:58.4 —1.8 +1.2 78°. Em: **A** 2:13.5 +1.1 +3.2 177°; **C** 2:06.4 . . . . . 172°; **E** 2:09.7 —0.7 +0.9 211°; **F** 1:49.0 —0.6 +2.4 195°; **H** 1:22.6 —2.1 +1.1 243°.

20-21 **Omicron Tauri** 4.8, 5:24.3 +21-53.5, 16, +76° +5° Im: **A** 6:31.0 —2.1 —2.0 124°; **C** 6:30.0 —2.8 —4.2 141°; **E** 5:52.4 —2.1 —0.4 114°; **H** 5:09.6 —0.6 +1.2 83°. Em: **A** 7:25.9 —1.7 +2.3 215°; **B** 7:29.3 —1.6 +1.3 228°; **C** 7:06.1 . . . . . 195°; **D** 7:16.9 —1.5 +1.9 222°; **E** 6:51.6 —1.3 +2.7 215°; **G** 6:38.8 —1.2 +0.9 273°; **H** 6:12.2 —0.8 +1.8 241°; **I** 6:27.3 —1.0 +1.0 279°.

21-22 **36 B Geminorum** 6.0, 6:22.2 +23-21.6, 17, +69° +6° Em: **A** 4:14.7 —1.2 +1.2 266°; **B** 4:16.6 —1.2 +0.9 276°; **C** 4:05.3 —1.0 +1.3 261°; **D** 4:08.2 —1.0 +1.0 277°; **E** 3:54.5 —0.7 +0.9 282°; **F** 3:41.1 —0.3 +1.0 265°; **H** 3:38.7 —0.3 —0.2 314°.

22-23 **58 Geminorum** 6.0, 7:20.2 +23-03.2, 18, +90° +24° Em: **A** 1:59.7 +0.4 +2.0 231°; **B** 2:05.8 +0.3 +1.8 240°; **C** 1:54.8 +0.6 +2.0 227°; **D** 2:04.6 +0.4 +1.7 242°.

22-23 **187 B Geminorum** 6.2, 7:37.7 +23-08.8, 18, +67° +2° Em: **A** 11:02.2 —1.2 —1.4 281°; **C** 10:59.6 —1.6 —0.7 265°; **D** 10:51.6 —1.4 —1.1 277°; **E** 10:32.4 —2.1 +0.3 254°; **G** 9:52.7 —1.5 0.0 285°; **H** 9:26.3 —1.5 +2.5 234°; **I** 9:39.3 —1.4 +0.4 283°.

23-24 MARS —0.2, ... , 19, +82° +8° Im: **A** 1:39.2 +0.4 +1.0 93°. Em: **A** 2:32.0 +0.2 +1.1 271°; **B** 2:35.4 +0.1 +1.1 279°; **C** 2:29.0 +0.3 +1.1 267°.

25-26 **42 Leonis** 6.1, 10:18.9 +15-15.2, 21, +49° —25° Em: **A** 6:58.9 —1.1 —1.2 329°; **B** 6:52.9 —1.0 —2.4 344°; **C** 6:57.0 —1.0 —0.5 315°; **D** 6:50.5 —0.9 —1.5 336°; **E** 6:45.2 —0.7 —0.8 327°.

For selected occultations (visible at three or more stations in the U. S. and Canada under fairly favorable conditions), these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, limiting parallels of latitude, immersion or emersion; standard station designation, G.C.T., a and b quantities in minutes, position angle; the same data for each standard station westward.

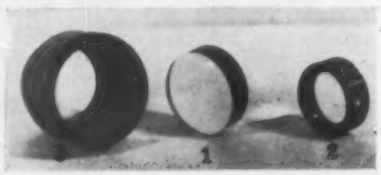
Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	**B** +73°.6, +45°.6
C +77°.1, +38°.9	**D** +79°.4, +43°.7
E +91°.0, +40°.0	**F** +98°.0, +30°.0
G +114°.0, +50°.9	**H** +120°.0, +36°.0
I +123°.1 +49°.5	

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard time.

For additional occultations consult the American Ephemeris and Nautical Almanac and the British Nautical Almanac, from which these predictions are taken. Texas predictions were computed by E. W. Woolard and Paul Herget.

Achromatic Wide-Angle Four Element Telescope Objective



5" equivalent focal length. Outside diameter: front, 1 9/16"; back, 1 5/16". Consists of $4.00

(1) Achromatic plano-convex lens, 1¼" diameter; 3¼" f. l. Outside surfaces fluoride coated.

(2) Achromatic negative lens in aluminum mount; 1 1/16" diameter; —12" f. l. Outside surfaces fluoride coated.

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Offers innumerable uses: Excellent wide-angle telephoto lens; superb enlarger and slide projector lens; covers 2½" x 2½" plate; wide-angle telescope objective for small finders; for Schmidt cameras; collimator, and macro-photo lens. Many other uses will suggest themselves. Works well with our focusing eyepiece. A gem of beautiful optical workmanship.

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A unique adaptation of polarized light. Used as a telescope and camera finder or shotgun sight, as well as for target sighting, centering and leveling. Includes a monochromatic deep-red filter; finely polished, plane parallel; metal mounted; 1 5/16" diameter. With mounting screws.

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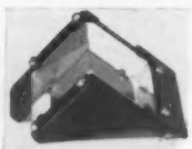

Fluoride coated, in mounting of aluminum-magnesium alloy, with ball bearing swivel. Meets most exacting requirements. 1 5/16" by 1¼" face. Suitable as diagonal for reflectors up to 8", also as star diagonal on refractors. These prisms can be used to make Porro's system No. 2 erector.

Porro-Abbe-dihedral prism 5/16" square face, each 15c.

To those who have purchased our focusing eyepiece we can supply an inverter which threads into their ocular, outside diameter 1¼". Price $7.00. This converts an astronomical to a terrestrial telescope.

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GLEANINGS FOR A.T.M.s

Bargains In Optical Elements

THERE have been appearing in recent issues of this and of other magazines advertisements offering for sale various types of lenses and prisms at very low prices. These, of course, come from optical manufacturers who have been making optical elements for military instruments. Undoubtedly many ATM's have seen these ads; probably some of them have wondered whether any of the items would be of value to them in their hobby. This article is for the benefit of those who are not sure just what the nature and quality of these items may be and who will be interested in knowing what use can be made of them.

Let us point out here that the writer has not personally examined the merchandise of any of the advertisers; the following is based entirely on his own knowledge of the source of these items and of the nature and quality of military optics in general.

In the first place, these offerings arise from two sources: excess production for instruments which have become obsolete or for which orders have been cancelled, and rejected items. The first will be, of course, of excellent quality. The second class, which probably represents a large majority of the items offered for sale, may have been rejected for over- or under-size, short or long focal length (lenses), angle errors (prisms), bubbles, small chips or scratches, or other causes which in practically no way affect the usefulness of the piece outside the instrument for which it was intended (see below for angle errors of prisms). No reputable firm should advertise as perfect optical elements which are chipped or scratched. Most material advertised should be relatively flawless and of good finish. However, when a purchaser receives merchandise which proves to be of a quality unfit for the purpose for which advertised, the seller should refund the purchase price upon return of the unsatisfactory material.

Lenses: Many achromatic lenses, of various diameters and focal lengths, are offered for sale. ATM's will probably find numerous uses for these, and this is an excellent opportunity to acquire a supply which may be laid away for future use in finders, spectroscopes, and other accessory equipment.

The general quality of the optical elements in military instruments is excellent, **for the use for which they are intended**, which is terrestrial observation. Unfortunately, it is extremely unlikely that an objective, for example, will be sufficiently well corrected for use as an astronomical telescope. Furthermore, there are few of these military instrument lenses of any appreciable size (two inches is about a maximum for diameters) and none of any considerable focal ratio (f/7 is a maximum, and most of them range around f/3 to f/5).

The larger lenses among these achromats will probably make suitable finders when used with low-power eyepieces. The focal length should be as great as possible, and in no case less than f/6 if any sort of definition is to be obtained. And do not expect definition equal to that of an astronomical refracting telescope of the same diameter and focal length.

The smaller lenses will probably be useful to have on hand, but do not expect too much in the way of image quality from a series of lenses selected at random. Lens surfaces are, of course, computed with due regard to all the components of the optical system involved, and are not to be expected to show good corrections in any other arrangement. However, so long as the magnification of an optical system is kept at a low value, and the objects to be viewed are not as critical as star images, fair results can be attained.

Eyepieces: Some of the offerings include eyepiece sets of unmounted lenses, which will probably be of value to the ATM. These eyepieces are of excellent quality and are always of the positive type. They cannot be had in short focal lengths, however. One inch is about the usual focal length for military instrument eyepieces, and less than ¾" is almost unknown.*

Prisms: Various types of prisms are offered, many of which would probably be very useful to the ATM. Right-angle prisms for Newtonian telescopes and for zenith eyepieces come most readily to mind, but very few prisms of this type are offered. One of the most frequently advertised offerings, however, is a tank-periscope prism which is a right-angle prism, although with a long rectangular instead of a square face. One of these could, without very much difficulty, be cut up into several ordinary right-angle prisms of moderately large size (about 1½" face). It is doubtful if there are any strains in the glass to be released by such cutting. The cutting can be done by a slow-speed brass disk with carborundum and water, or, better, a copper disk impregnated with diamond dust, or a thin (1/16" or 1/8") carborundum grinding wheel, a "glass saw" made for just this purpose.

* See **Sky and Telescope**, February, 1944, page 18, for a discussion of eyepiece sizes.

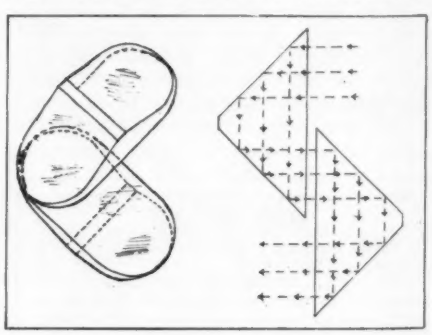

Fig. 1. Arrangement of the Porro prism erecting system.

It was mentioned above that these prisms may have been rejected for angular errors. Deviation errors and pyramidal errors are the two possible types. The first means that the prism does not deviate the light through the required angle; the second means that there is an error in a plane perpendicular to both the joining faces, which will cause the image plane to be skewed around and tilted. Neither of these errors need concern the man who is building an instrument around a particular prism, since it is assumed that he will align the parts so that the best possible definition is attained, and in his mechanical construction will thus automatically compensate for the errors of the prism. In any case, these errors are probably not more than a few minutes of arc. Prisms with angular errors, however, and especially those with pyramidal errors, are not suitable in the erecting systems described below.

Prism Erecting System: The ATM may wish to add an erecting system to some of his instruments, and prism erecting systems are to be preferred, since they add nothing to the length of the instrument. Three types are available.

The ordinary Porro prism erecting system is that used universally in prism binoculars. It consists of two identical prisms mounted 90° to each other as shown in Fig. 1, with the separation between the prisms anything desired to accommodate the focal length of the objective used. The light path is shown schematically in the figure. The prisms should be mounted to provide adjustment so that they may be brought to 90° from each other by optical test.

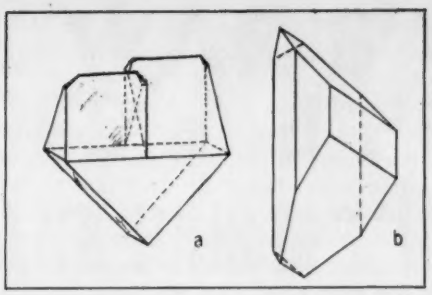

Fig. 2. The Abbe-Porro or second-type Porro erecting system (left), and the Amici prism (right).

The so-called Abbe-Porro system, or second-type Porro system, consists of three prisms: one regular Porro prism, and two small right-angle prisms, mounted as shown in Fig. 2a. This unit is usually cemented together. The same precautions as above with respect to orientation of the prisms with one another are necessary.

A Porro prism may be used as a right-angle prism if desired, but if this is done, there is waste space in the prism, because the entrance face of a Porro prism used as a right-angle prism is rectangular and not square. The two prisms may be identified by the length of the hypotenuse face, 1.4 to 1 ratio to sides for a right-angle prism, 2 to 1 for a Porro. Also, the Porro prism is usually rounded at the ends as shown in Fig. 1.

The Amici (Fig. 2b) is a roof prism, combining an erecting system with a right-angle deviation. This prism would be excellent for a Newtonian telescope for terrestrial use, but usually cannot be obtained in a size large enough. Used below the eyepiece of a Cassegrainian or Gregorian, however, it may be small, and will make a compact terrestrial telescope out of the instrument.

We hope that the above may be of help to those who have mentally pondered the advisability of purchasing some of these optical items, and those to whom some of the prisms may not be recognizable by name alone. We cannot comment on the usefulness of the "optical lens sets" which are offered. Booklets telling how to build various instruments out of the items offered are also available.

As to the prices, it goes without saying that they are only a fraction of what the items would cost if made and sold for a specific application. For the ATM who expects to do any experimenting with lenses and prisms, this is an opportunity worth attention.

Small lenses, of course, are relatively easy to make in the home workshop, and it is surprising that more ATM's have not gone into this work. The making of prisms, however, can hardly be carried on at all except in reasonably large quantities (a dozen or more in one block), and hence is not likely to appeal to amateurs as a workshop project. At this point, "Unc" Ingalls of **Scientific American** would remark that this very fact makes it extremely likely that some ATM will go to work to make **one** prism—just to show it can be done. And we are inclined to agree with him.

E. B. B.

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36 mm.	180 mm.	$2.00
20 mm.	95 "	2.00
18 mm.	95 "	2.00

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COSMOGONICAL IMPLICATIONS OF THE ATOMIC BOMB

(Continued from page 5)

balls are regarded as perfectly smooth and elastic, the collisions would continue until (according to probability laws) the kinetic energy might be once more concentrated in a single ball close to the edge. This ball would escape and the remainder of the balls would have insufficient energy for any of them to climb the slope.

According to Bohr's view, the particles within a fairly heavy nucleus are distributed in different energy levels. These are similar to, but not to be confused with, the energy levels in the electrons which complete the atom outside the nucleus. The lowest energy levels in the nucleus correspond to ordinary excited gamma-ray states. As the diagram on page 5 shows, these low levels, such as at 10×10^6 e.v., are distinctly and well separated, but with increasing excitation they rapidly become closer to one another. For about 15 million electron volts, corresponding to a nucleus-neutron collision, there is practically continuous distribution and the sharing of the neutron energy results therefrom. For collisions involving about a thousand million (10^9) e.v., Bohr expects this sharing to end in an explosion of the whole nucleus, which thought leads directly to the disruption of uranium nuclei when they are bombarded with fast neutrons. We shall see how slow neutrons produce the fission of some heavy elements into two nuclei, a phenomenon which was discovered later.

(To be continued)

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SKY-GAZERS EXCHANGE

Classified advertisements are accepted for this column at 30c a line per insertion, 7 words to the line. Minimum ad 3 lines. Remittance must accompany orders. Address Ad Dept., Sky and Telescope, Harvard College Observatory, Cambridge 38, Mass.

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PLANETARIUM NOTES

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Mondays through Saturdays ..... 3 and 8:30 p.m.
Sundays and Holidays ..... 3, 4, and 8:30 p.m.

★ STAFF—*Director*, Arthur L. Draper; *Lecturer*, Nicholas E. Wagman; *Manager*, Frank S. McGary; *Public Relations*, John F. Landis; *Chief Instructor of Navigation*, Fitz-Hugh Marshall, Jr.; *Instructor, School of Navigation*, Edwin Ebbighausen.

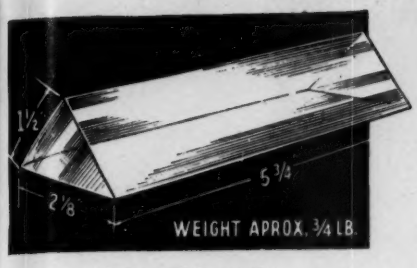
★ SCHEDULE HAYDEN PLANETARIUM

Mondays through Fridays ..... 2, 3:30, and 8:30 p.m.
Saturdays ..... 11 a.m., 2, 3, 4, 5, and 8:30 p.m.
Sundays and Holidays ..... 2, 3, 4, 5, and 8:30 p.m.

★ STAFF—*Honorary Curator*, Clyde Fisher; *Chairman and Curator*, Gordon A. Atwater; *Associate Curator*, Marian Lockwood; *Assistant Curator*, Robert R. Coles; *Scientific Assistant*, Fred Raiser; *Lecturers*, Catharine E. Barry, Shirley I. Gale, John Saunders, Robert Snedigar.

UNUSUAL WAR BARGAINS in LENSES and PRISMS

TANK PRISMS



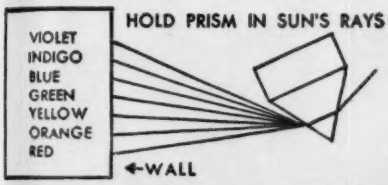
SILVERED TANK PRISM
Stock #3004-Y.....$2.00 each Postpaid

PLAIN TANK PRISM
Stock #3005-Y.....$2.00 each Postpaid

FOUR TANK PRISMS—Special—$7.00 Postpaid
The most **sensational** bargain we have ever been able to offer.

In order that the tank driver shall not get shot in the face, 2 of these Silvered Prisms are used to make a Periscope. We have secured a number of these that are very slightly chipped, making possible their sale at a very low price. They are 90-45-45 degree Prisms of huge size—5¾" long, 2⅛" wide, finely ground and polished. Used to build a Periscope . . . excellent also for experiments, class-room demonstrations. Some of our ingenious customers have used these prisms to make camera stereo attachment, range finder, etc. Prism easily converted into desk name plate by affixing gold letters. 100 gold letters supplied at only 10c. (Order Stock #3008-Y). Normally these Prisms would retail from $24 to $30 each.

HOLD PRISM IN SUN'S RAYS



TO SEE THE COLORS OF THE SPECTRUM,
Hold a plain tank prism in sun's rays as shown in drawing. White incident light which passes through prism is thus broken up into a band of primary colors known as the spectrum—a beautiful sight! By looking through a tank prism at a certain angle, you can see a world of colors everywhere. Truly amazing!

All Items Finely Ground and Polished but Edges Slightly Chipped or Other Slight Imperfections Which We Guarantee Will Not Interfere with Their Use. Come Neatly Packed and Marked. EXCELLENT for XMAS GIFTS.

WE URGE YOU TO BUY NOW!

War Production of Optical Items has ceased. Once our supply of Surplus Optics is exhausted, you will never again be able to buy Lenses and Prisms at such bargain prices.

16 MM. PROJECTOR CONDENSING LENSES—Consists of two Condensing Lenses with combined F.L. of one inch.
Stock #4026-Y.....$1.00 Postpaid

8 MM. PROJECTOR CONDENSING LENSES . . . Consists of two Condensing Lenses with combined F.L. of ½ inch.
Stock #4027-Y.....$1.00 Postpaid

RECTICLE SET—5 assorted, engraved recticles from U S. Gunsights.
Stock #2035-Y.....$1.00 Postpaid

MAGNIFIER SET—5 magnifying Lenses—Powers from 1 to 10.
Stock #1026-Y.....$2.00 Postpaid

LENS FOR KODACHROME EYE-VIEWER—Color corrected cemented Lens 38 mm. diam., 2 inch F.L.
Stock #6129-Y.....$1.00 Postpaid

14-POWER COLOR CORRECTED MAGNIFIER SET—Consists of 2 perfect 18 m.m. diam. Achromatic Lenses and section of metal tubing for mount.
Stock #1044-Y.....$1.55 Postpaid

OPTICS FROM 4-POWER PANORAMIC TELESCOPE
Excellent condition. Consists of Objective Prism, Dove Prism, Achromatic Objective Lens, Amici Roof Prism, Eye Lens Set (. . . a $60.00 value).
Stock #5016-Y.....$6.00 Postpaid

MONOCULAR SET OF LENSES AND PRISMS . . . From Navy's 7 x 50 Binocular. All the optics you need to make a 7 Power Monocular. (Buy 2 sets to make a Binocular.) Complete Directions included.
Stock #5101-Y.....$5.00 Postpaid

SPECTROSCOPE SETS . . . These sets contain all Lenses and Prisms you need to make a Spectroscope plus FREE 15-page Instruction Booklet.
Stock #1500-Y—Hand Type Spectroscope
$3.45 Postpaid

Stock #1501-Y—Laboratory Type Spectroscope.
$6.50 Postpaid

MICROSCOPE SETS
Consisting of 4 Cemented Achromatic Lenses for making a 40 Power Pocket Microscope or 140 Power regular size Microscope. These color corrected Lenses will give you excellent definition and may be used for micro-photography.
Stock #1037-Y.....$3.00 Postpaid

Consisting of Prism, Mirror and Condensing Lens. These used together with Stock #1037-Y will make an excellent Microprojector enabling you to get screen magnification of 400 to 1000 Power according to screen distance.
Stock #1038-Y.....$2.00 Postpaid

SPECIALS IN LENS SETS

Set #1-Y — "Our Advertising Special" — 15 lenses for $1.60 Postpaid, plus 10-page idea booklet. For copying, ULTRA CLOSE-UP SHOTS macrophotography, experimental optics, magnifying and for making a two power f/16 Telephoto Lens, "Dummy Camera," Kodachrome Viewer, DETACHABLE REFLEX VIEW-FINDER for 35 mm. cameras, stereoscopic viewer, ground glass and enlarging focusing aids, TELESCOPES, low power Microscopes and for many other uses.

Set #15-Y — "The Experimenter's Dream" — 62 Lenses, Prisms and Optical Items, and New 50-page Book, "Fun With Chipped Edge Lenses." $15.00 Postpaid. The variety of Lenses and Prisms in this set will enable you to conduct countless experiments, build a great variety of Optical Equipment. **A sensational buy.**

NEW 50-PAGE IDEA BOOK "FUN WITH CHIPPED EDGE LENSES"
Contains wide variety of projects and fully covers the fascinating uses of all Lenses in sets listed above . . only **$1.00 Postpaid.**

ALL THE LENSES YOU NEED TO MAKE YOUR OWN TELESCOPE!

ALL ARE ACHROMATIC LENSES

GALILEAN TYPE—Simplest to Make but has Narrow Field of View.

Stock #5003-Y—Power of either 5, 6 or 10
$1.60 Postpaid

Stock #5004-Y—Small 2 Power Pocket Scope
$1.00 Postpaid

TERRESTRIAL TYPE—Have Much Wider Field of View than Galilean Type.
Stock #5007-Y—11 Power Telescope
$3.20 Postpaid

Stock #5008-Y—20 Power Telescope
$3.45 Postpaid

Stock #5009-Y—40 Power Telescope
$7.45 Postpaid

PRISM TELESCOPES—Use Prism instead of Lenses to Erect Image and are much shorter than Terrestrial Type. Have wide field of view.
Stock #5010-Y—6 Power Telescope
$3.00 Postpaid

Stock #5011-Y—11 Power Telescope
$3.25 Postpaid

Stock #5012-Y—20 Power Telescope
$7.25 Postpaid

MISCELLANEOUS ITEMS

Stock No.	Item	Price
2024-Y	10 Pieces Circular A-1 Plate Glass (Diam. 31 mm.—for making Filter)	.25
3020-Y	Right Angle Prism 48 mm. wide (3rd grade). Each	.35
523-Y	Six Threaded Metal Reticle Cells	.25
26-Y	First Surface Aluminized Mirror, Diam. 1¼". Each	.25
624-Y	Neutral Ray Filter, size 4¾" x 2½"	.25
3022-Y	Round Wedge, 65 mm. Diam. Each	5.00
3021-Y	Amici Roof Prism (3rd grade). Each	.25
4009-Y	Heat Absorbing Glass 4" x 5". Each	.35
4010-Y	Heat Absorbing Glass 2" x 2". Each	.10
22-Y	Inclinometer—Aircraft type. Each	.25
704-Y	Lens Cleaning Tissue, one ream (480 sheets), size 7½" x 11"	1.50
1030-Y	2" Diam. Reducing Lens. Each	.25
1031-Y	Perfect 6 Power Magnifier. Diam. 28 mm.	.25
2043-Y	Standard Crossline Reticle. Diam. 29 mm. Each	.50
1034-Y	Burning Glass Lens. Each	.25

(Minimum Order on Above—$1.00)

RAW OPTICAL GLASS
An exceptional opportunity to secure a large variety of Optical Pieces both Crown and Flint glass (seconds) in varying stages of processing. Many prism blanks.
Stock #703-Y—8 lbs. (min. weight). ... $5.00 Postpaid

CLEANING BRUSH SET . . . For Lenses, Optical instruments, etc. Perfect quality—12 inch Flexible Plastic handle, hollow circular const. Range from stiff to very soft. 4 Brushes to set.
Stock #504-Y—(Reg. $6.00 value) ..... Price $1.00

PRISMS

Stock No.	Type	Base Width	Base Length	Price
3040-Y	Right Angle	33 mms.	23 mms.	$.100
3042-Y	Right Angle	41 mms.	40 mms.	1.00
3045-Y	Right Angle	70 mms.	168 mms.	8.00
3001-Y	Lens Surface	20 mms.	14 mms.	2.00
3006-Y	Porro-Abbe	9 mms.	9 mms.	.25
3009-Y	Porro	52 mms.	25 mms.	1.00
3010-Y	Porro	43 mms.	21 mms.	.50
3016-Y	Pentagon	45 mms.	22 mms.	.75
3029-Y	Dove	18 mms.	65 mms.	1.25
3036-Y	90 Degree Roof	60 mms.	36 mms.	4.00
6136-Y	Rhomboid	20 mms.	17 mms.	.50
3049-Y	Right Angle	69 mms.	167 mms.	10.00
3047-Y	Right Angle	53 mms.	103 mms.	4.00
3038-Y	Roof Prism	18 mms.	34 mms.	2.50

TANK PERISCOPE

Complete Set Mounted Components

Rugged, strong, originally constructed for U. S. Tank Corps. Consists of 2 fine Periscope Mirrors mounted in metal and plastic. Perfect condition. Only plywood body frame is required to finish this exceptional Periscope. First surface mirror is well protected by glass windows.

Set weighs 2¾ lbs. Overall length of mount 6⅛", width 2⅛". Would normally retail at $40 to $50.

Stock #700-Y.....$3.00 Complete Set Postpaid

TWO SETS (4 UNITS).....SPECIAL $5.50 Postpaid

ORDER BY SET OR STOCK NO. ◎ ***SATISFACTION GUARANTEED***

EDMUND SALVAGE COMPANY . P. O. AUDUBON, NEW JERSEY

EVENING STARS FOR SOUTHERN OBSERVERS

THIS is the eighth map in the series of star charts for use by observers in the Southern Hemisphere, and matching the northern maps. It is prepared for a basic latitude of 30° south, but may be used conveniently 20 degrees on either side of that parallel. These southern charts appear in alternate months, but always two or three months in advance, to allow time for transmission to observers in any part of the world. When 12 charts have been produced, and if interest warrants, a special edition of **Sky and Telescope** may be published each month carrying observing material for Southern Hemisphere observers. This chart is for use in latitudes 20° to 40° south on January 7th at 11 p.m., January 23rd at 10 p.m.. February 7th and 23rd at 9 p.m. and 8 p.m., respectively. Times for other days vary similarly: four minutes earlier per day. These are local mean times which must be corrected for standard time and war time differences. The 30° horizon is a solid circle; the other horizons are circles, too, those for 20° and 40° south being dashed in part. When facing south, hold "South" at the bottom, and similarly for other directions. Observers in the tropics may find north circumpolar stars on any of our northern star charts.

DEEP-SKY WONDERS

AMONG marvels for observation in the November skies are the objects listed here, some of which are not shown on the chart above. The informal descriptions are for common telescopes.

Sculptor. NGC 55 (2315h), $0^h\ 12^m.5$, $-39°\ 30'$; fluffy galaxy. After M31 and M33, apparently largest spiral.

Cassiopeia. NGC 457, $1^h\ 12^m.8$, $+57°\ 48'$; cluster of 100 stars. Like a bee with spread wings. NGC 663, $1^h\ 39^m.2$, $+60°\ 44'$; cluster of 80 stars.

Cetus. NGC 247, $0^h\ 44^m.6$, $-21°\ 01'$; large, dim spiral. M77, $2^h\ 40^m.1$, $-0°\ 14'$; spiral, small, bright.

Triangulum. In M33 is a starcloud, which, for want of a popular name, let us call the Knot. In a small telescope, you can see only the heart of M33, $1^h\ 31^m.1$, $+30°\ 24'$, but a 12-inch reveals the Knot, which follows about 17′ farther south.

L. S. COPELAND

STARS FOR NOVEMBER

from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., standard time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.